2. Subbasin Assessment – Water Quality Concerns and Status

2.1 Water Quality Limited Segments Occurring in the Subbasin

Section 303(d) of the CWA states that waters unable to support their designated beneficial uses and that do not meet water quality criteria must be listed as water quality limited waters. Subsequently, these waters are required to have a TMDL developed to bring them into compliance with water quality standards.

About Assessment Units

The following discussion focuses on the new way that DEQ defines the waters of the state of Idaho. This identification methodology was not utilized in the 1998 303(d) list that this TMDL addresses. However, since AUs now define all the waters of the state of Idaho, the methodology is described in this section. These units and the methodology used to describe them can be found in the WBAGII (Grafe et al 2002). Assessment units (AUs) are groups of similar streams that have similar land use practices, ownership, or land management. Stream order, however, is the main basis for determining AUs—although ownership and land use can change significantly, the AU remains the same.

Using assessment units to describe water bodies offers many benefits, the primary benefit being that all the waters of the state are now defined consistently. In addition, using AUs fulfills the fundamental requirement of EPA's 305(b) report, a component of the Clean Water Act wherein states report on the condition of all the waters of the state. Because AUs are a subset of water body identification numbers, there is now a direct tie to the water quality standards for each AU, so that beneficial uses defined in the water quality standards are clearly tied to streams on the landscape.

However, the new framework of using AUs for reporting and communicating needs to be reconciled with the legacy of 303 (d) listed streams. Due to the nature of the court-ordered 1994 303(d) listings, and the subsequent 1998 303(d) list, all segments were added with boundaries from "headwater to mouth." In order to deal with the vague boundaries in the listings, and to complete TMDLs at a reasonable pace, DEQ set about writing TMDLs at the watershed scale (HUC), so that all the waters in the drainage are and have been considered for TMDL purposes since 1994.

The boundaries from the 1998 303(d) listed segments have been transferred to the new AU framework, using an approach quite similar to how DEQ has been writing SBAs and TMDLs. All AUs contained in the listed segment were carried forward to the 2002 303(d) listings in Section 5 of the Integrated Report. AUs not wholly contained within a previously listed segment, but partially contained (even minimally), were also included on the 303(d) list. This was necessary to maintain the integrity of the 1998 303(d) list and to maintain continuity with the TMDL program. These new AUs will lead to better assessment of water quality listing and de-listing.

When assessing new data that indicate full support, only the AU that the monitoring data represents will be removed (delisted) from the 303(d) list (Section 5 of the Integrated Report).

Listed Waters

Figure 18 shows the listed water bodies in the basin. Table 2 shows the 303 (d) pollutant listings in the basin. Not all of the water bodies will require a TMDL, as will be discussed later. However, a thorough investigation using the available data was performed before this conclusion was made. This investigation, along with a presentation of the evidence of non-compliance with standards is contained in the following sections for each water body.

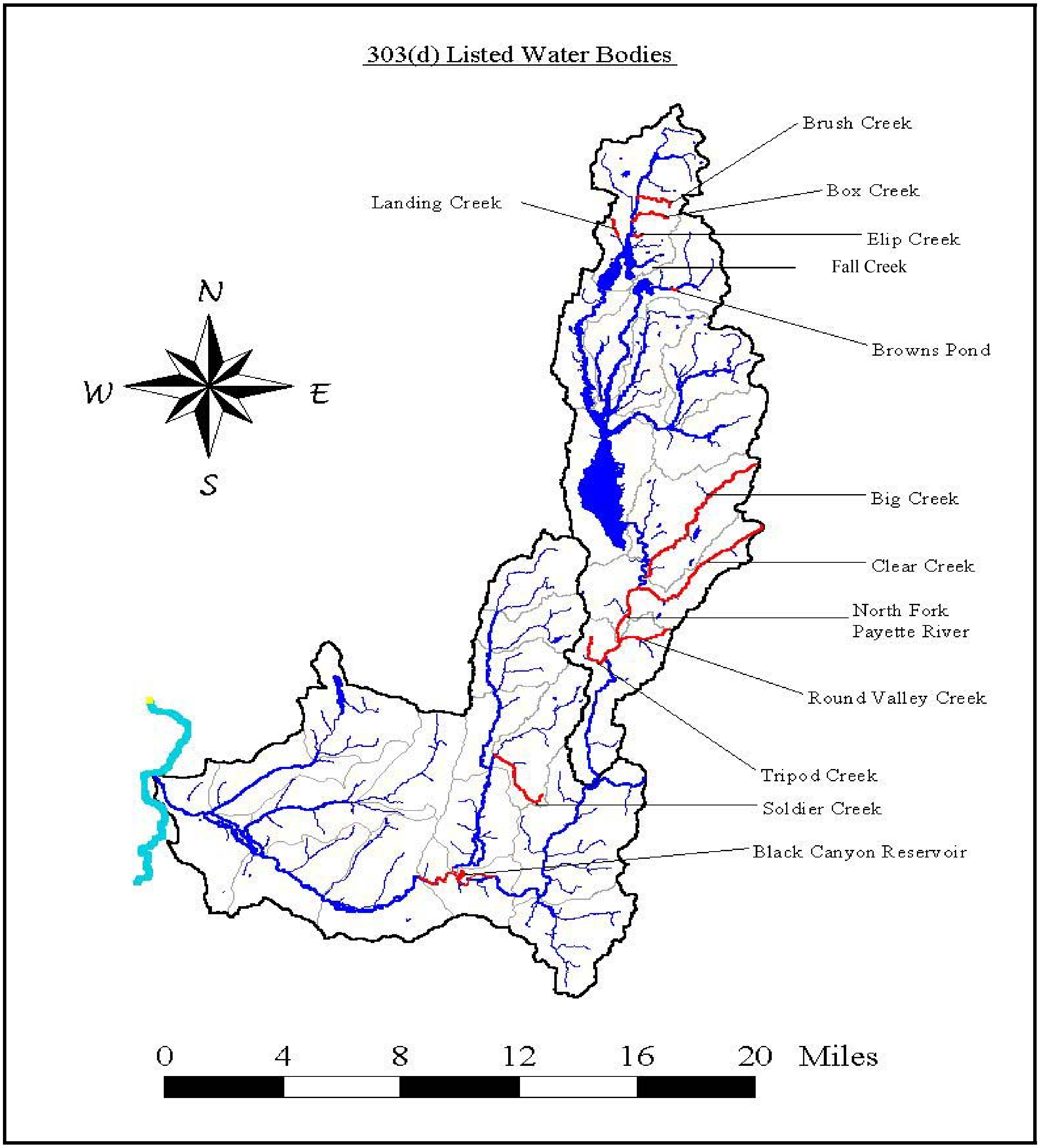

Figure 18. 1998 Idaho 303(d) Listed Water Bodies.

Table 2. Idaho 1998 §303(d) list Water Bodies, Water Body Description, Miles of Impaired Water Bodies and Pollutant of Concern, North Fork Payette River Watershed.

Water Body	Assessment Units	1998 §303(d)[1] Boundaries	Basis for Listing	Pollutant(s)	Miles/Acres of Impaired Water Bodies
Payette River (HUC 17050122)					
Black Canyon Reservoir	SW002-06	Black Canyon Reservoir	305(b), Append. D	Nutrients, Oil/Grease and Sediment	6
Soldier Creek	SW012-02	Headwaters to Squaw Creek	US Forest Service	Sediment	8.96
North Fork Payette River (HUC 17050123)					
North Fork Payette River	SW001-06	Clear Creek to Smith's Ferry	305(b), Append. D	Flow alteration, Habitat alteration, Nutrients, Sediment and Temperature	9.53
Round Valley Creek	SW002-03	Headwaters to North Fork Payette River	305(b), Append. D	Sediment	5.66
Clear Creek	SW003-03	Headwaters to North Fork Payette River	Salmonid Spawning, US Forest Service	Sediment	17.78
Big Creek	SW004-03	Horsethief Creek to North Fork Payette River	US Forest Service	Sediment	6.50
Tripod Creek	SW001-02	Headwaters to North Fork Payette River	BURP	Unknown	5.40
North Fork Payette River (at or above BPL) (HUC 17050123)					
Box Creek	SW018-02	Headwaters to North Fork Payette River	Added by EPA, April 2000	Temperature	4.5
Brown's Pond	SW014-02	Brown's Pond	305(b), Append. D	Habitat Alteration	<1
Brush Creek	SW018-02	Headwaters to North Fork Payette River	Salmonid Spawning, US. Forest Service	Unknown	5.06
Elip Creek	SW017-02	Headwaters to Lemah Creek	Salmonid Spawning, US. Forest Service	Unknown	3.00
Fall Creek	SW017-03	Headwaters to Big Payette Lake	Added by EPA, April 2000	Temperature	4.8
Landing Creek	SW017-02	Headwaters to Deadhorse Creek	BURP	Unknown	2.42

[1]Refers to a list created in 1998 of water bodies in Idaho that did not fully support at least one beneficial use. This list is required under Section 303 subsection "d" of the Clean Water Act.

2.2 Applicable Water Quality Standards

Idaho adopts both narrative and numeric water quality standards to protect public health and welfare, enhance the quality of water, and protect biological integrity. By designating the beneficial use or uses for water bodies, Idaho has created a mechanism for setting criteria necessary to protect those uses and prevent degradation of water quality through *anti-degradation* provisions. According to IDAPA 58.01.02.050 (02)a "wherever attainable, surface waters of the state shall be protected for beneficial uses which includes all recreational use in and on the water surface and the preservation and propagation of desirable species of aquatic *biota*." Beneficial use support is determined by DEQ through its water body assessment process. Table 3 contains a listing of the designated beneficial uses for each listed segment. Table 4 is a summary of the water quality standards associated with the beneficial uses. For streams with no designated beneficial uses, cold water aquatic life and recreation are presumed to be uses. The following discussion focuses on beneficial uses and the water quality criteria, both narrative and numeric, that apply to each listed water body. A more detailed explanation of numeric water quality targets developed as an interpretation of the narrative standards for nutrients and sediment can be found later in this section.

Table 3. Idaho 1998 §303(d)[1] list Water Bodies, Designated Uses and IDAPA Citation for the North Fork Payette River TMDL.

Water Body	Assessment Unit	Designated Uses[2]	IDAPA §
Payette River			
Black Canyon Reservoir	SW002-06	CW; SS; PCR ; DWS; SRW	58.01.02.140.16.SW-2
Soldier Creek	SW012-02	Undesignated	58.01.02.140.16.SW-12
Payette River (confluence of NF and SF to Black Canyon Reservoir)	SW002-06	CW; SS; PCR ; DWS; SRW	58.01.02.140.16.SW-3
North Fork Payette River			
North Fork Payette River	SW001-06	CW; SS; PCR ; DWS; SRW	58.01.02.140.17.SW-1
Round Valley Creek	SW002-03	Undesignated	58.01.02.140.17.SW-2
Clear Creek	SW003-03	Undesignated	58.01.02.140.17.SW-3
Big Creek	SW004-03	Undesignated	58.01.02.140.17.SW-4
Tripod Creek	SW001-02	CW;SS;PCR;DWS;SRW	58.01.02.140.17.SW-1
North Fork Payette River (at or above Big Payette Lake)			
Box Creek	SW018-02	CW;SS;PCR;DWS;SRW	58.01.02.140.17.SW-18
Brown's Pond	SW014-02	CW; SS; PCR ; DWS; SRW	58.01.02.140.17.SW-14
Brush Creek	SW018-02	CW;SS;PCR;DWS;SRW	58.01.02.140.17.SW-18
Elip Creek	SW017-02	CW;SS;PCR;DWS;SRW	58.01.02.140.17.SW-18
Fall Creek	SW017-03	CW;SS;PCR;DWS;SRW	58.01.02.140.17.SW-18
Landing Creek	SW017-02	CW;SS;PCR;DWS;SRW	58.01.02.140.17.SW-18

[1] Refers to a list created in 1998 of water bodies in Idaho that did not fully support at least one beneficial use. This list is required under Section 303 subsection "d" of the Clean Water Act. [2] CW – Cold Water Aquatic Life, SS – Salmonid Spawning, PCR – Primary Contact Recreation, SCR – Secondary Contact Recreation, AWS – Agricultural Water Supply, DWS – Domestic Water Supply, SRW-Special Resource Water

Table 4. Applicable Water Quality Criteria

Pollutant & IDAPA Citation	Beneficial Use(s)	Applicable Water Quality Standard
Temperature (58.01.02.250.02.b) (58.01.02.200.09) (58.01.02.250.02.e.ii) Bull Trout Temperature Criteria (58.01.02.250.02.f)	Cold Water Aquatic Life (CWAL) Salmonid Spawning (SS)	Water temperatures of twenty-two (22) degrees C or less with a maximum daily average of no greater than nineteen (19) degrees C. Natural Background Conditions. When natural background conditions exceed any applicable water quality criteria set forth in Sections 210, 250, 251, 252, or 253 of the Idaho Administrative Rules, the applicable water quality criteria shall not apply; instead, pollutant levels shall not exceed the natural background conditions, except that temperature levels may be increased above natural background conditions when allowed under Section 401. During salmonid spawning periods: Water temperatures of thirteen (13) degrees C or less with a maximum daily average no greater than nine (9) degrees C. Water temperatures shall not exceed thirteen degrees Celsius (13C) maximum weekly maximum temperature (MWMT) during June, July and August for juvenile bull trout rearing, and nine degrees Celsius (9C) daily average during September and October for bull trout spawning. The bull trout temperature criteria shall apply to all tributary waters, not including fifth order main stem rivers, located within areas above 1400 meters elevation south of the Salmon River basin- Clearwater River basin divide, and above 600 meters elevation north of the Salmon River basin- Clearwater River basin divide, in the fifty-nine (59) Key Watersheds listed in Table 6, Appendix F of Governor Batt's State of Idaho Bull Trout Conservation Plan, 1996, or as designated under Sections 110 through 160 of this rule.
Dissolved Oxygen (58.01.02.250.02.a) Dissolved Oxygen Concentration below Existing Dam (58.01.02.276.02)	CWAL SS	**Cold Water**. Waters designated for cold water aquatic life are not to vary from the following characteristics due to human activities: **a.** Dissolved Oxygen Concentrations exceeding six (6) mg/l at all times. In lakes and reservoirs this standard does not apply to: i. The bottom twenty percent (20%) of water depth in natural lakes and reservoirs where depths are thirty-five (35) meters or less. (7-1-93) ii. The bottom seven (7) meters of water depth in natural lakes and reservoirs where depths are greater than thirty-five (35) meters. iii. Those waters of the hypolimnion in stratified lakes and reservoirs. From June 15-October 15 waters below dams, reservoirs and hydroelectric facilities shall contain the following dissolved oxygen concentrations: 30- day mean of 6.0 mg/L; 7-day mean of 4.7 mg/L and an instantaneous minimum of 3.5 mg/L
Turbidity (58.01.02.250.02.d)	CWAL	< 50 NTU[1] above background for any given sample or < 25 NTU for more than 10 consecutive days (below any applicable mixing zone set by DEQ)
Bacteria (58.01.02.251.01.b,c)	Primary Contact Recreation (PCR) Secondary Contact Recreations (SCR)	Waters designated for primary contact recreation are not to contain E.coli bacteria significant to the public health in concentrations exceeding: **a.** For areas within waters designated for primary contact recreation that are additionally specified as public swimming beaches, a single sample of two hundred thirty-five (235) E. coli organisms per one hundred (100) ml. **b.** For all other waters designated for primary contact recreation, a single sample of four hundred six (406) E.coli organisms per one hundred (100) ml; or **c.** A geometric mean of one hundred twenty-six (126) E.coli organisms per one hundred (100) ml based on a minimum of five (5) samples taken every three (3) to five (5) days over a thirty (30) day period. Waters designated for secondary contact recreation are not to contain E.coli bacteria significant to the public health in concentrations exceeding: **a.** A single sample of five hundred seventy-six (576) E.coli organisms per one hundred (100) ml; or **b.** A geometric mean of one hundred twenty-six (126) E.coli organisms per one hundred (100) ml based on a minimum of five (5) samples taken every three to five days over a thirty day period.

Table 4. (continued)

Floating, Suspended, or Submerged Matter (Nuisance Algae) (58.01.02.200.05)	PCR SCR CWAL	Surface waters shall be free from floating, suspended, or submerged matter of any kind in concentration causing nuisance or objectionable conditions or that impair designated beneficial uses and be free from oxygen demanding materials in concentrations that would result in an anaerobic water condition.
Excess Nutrients (58.01.02.200.06)	CWAL PCR SCR	Surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses.
Sediment (58.01.02.200.08)	CWAL SS	Sediment shall not exceed quantities specified in general surface water quality criteria (IDAPA 58.01.02.250 or 252) or, in the absence of specific sediment criteria, quantities which impair designated beneficial uses

[1]NTU = nephlometric turbidity unit

Beneficial Uses

Idaho water quality standards require that surface waters of the state be protected for beneficial uses, wherever attainable (IDAPA 58.01.02.050.02). These beneficial uses are interpreted as existing uses, designated uses, and "presumed" uses as briefly described in the following paragraphs. The *Water Body Assessment Guidance*, second edition (IDEQ 2002) gives a more detailed description of beneficial use identification for use assessment purposes.

For the North Fork Payette River, the Mainstem Payette River and the associated listed tributaries, designated beneficial uses for which support status must be determined include; cold water aquatic life (CWAL), salmonid spawning (SS), primary contact recreation (PCR) or secondary contact recreation (SCR), domestic water supply and special resources water. The listed pollutants impairing these uses include nutrients, oil and grease, sediment, temperature, habitat alteration and flow alteration. Table 2 shows the state of Idaho 1998 §303(d) listed segments, the description of the water body, segment Water Quality Limited Segment ID, the miles of impaired water body, the pollutant of concern and the basis for listing the segment. More detailed citation of the water quality standards can be found in Appendix B. Figure 29 shows the Idaho 1998 §303(d) listed water bodies.

Existing Uses

Existing uses under the CWA are "those uses actually attained in the water body on or after November 28, 1975, whether or not they are included in the water quality standards." The existing in stream water uses and the level of water quality necessary to protect the uses shall be maintained and protected (IDAPA 58.01.02.003.35, .050.02, and 051.01 and .053). Existing uses include uses actually occurring, whether or not the level of quality to fully support the uses exists. Practical application of this concept would be when a water body could support salmonid spawning, but salmonid spawning is not yet occurring.

Designated Uses

Designated uses under the CWA are "those uses specified in water quality standards for each water body or segment, whether or not they are being attained." Designated uses are simply uses officially recognized by the state. In Idaho these include things like aquatic life support, recreation in and on the water, domestic water supply, and agricultural use. Water quality must be sufficiently maintained to meet the most sensitive use. Designated uses may be added or removed using specific procedures provided for in state law, but the effect must not be to preclude protection of an existing higher quality use such as cold water aquatic life or salmonid spawning. Designated uses are specifically listed for water bodies in Idaho in tables in the Idaho water quality standards (see IDAPA 58.01.02.003.22 and .100, and IDAPA 58.01.02.109-160 in addition to citations for existing uses.)

Presumed Uses

In Idaho, most water bodies listed in the tables of designated uses in the water quality standards do not yet have specific use designations. These undesignated uses are to be designated. In the interim, and absent information on existing uses, DEQ presumes that most waters in the state will support cold water aquatic life and either primary or secondary contact recreation (IDAPA 58.01.02.101.01). To protect these so-called "presumed uses," DEQ will apply the numeric criteria cold water and primary or secondary contact recreation criteria to undesignated waters. If in addition to these presumed uses, an additional existing use, (e.g., salmonid spawning) exists, because of the requirement to protect levels of water quality for existing uses, then the additional numeric criteria for salmonid spawning would additionally apply (e.g., *intergravel dissolved oxygen*, temperature). However, if for example, cold water is not found to be an existing use, a use designation to that effect is needed before some other aquatic life criteria (such as seasonal cold) can be applied in lieu of cold water criteria. (IDAPA 58.01.02.101.01).

Criteria to Support Beneficial Uses

As shown in Table 4, the above-mentioned beneficial uses are protected by a set of criteria, which include *narrative* criteria for pollutants such as sediment and nutrients and *numeric* criteria for pollutants such as dissolved oxygen, pH, and turbidity (IDAPA 58.01.02.250).

DEQ's procedure to determine whether a water body fully supports designated and *existing beneficial uses* is outlined in IDAPA 58.01.02.053. The procedure relies heavily upon biological *parameters* and is presented in detail in the Water Body Assessment Guidance (Grafe et al. 2002). This guidance requires the use of the most complete data available to make beneficial use support status determinations. Figure 19 provides an outline of the wadeable stream assessment process for determining support status of the beneficial uses of cold water aquatic life, salmonid spawning, and contact recreation.

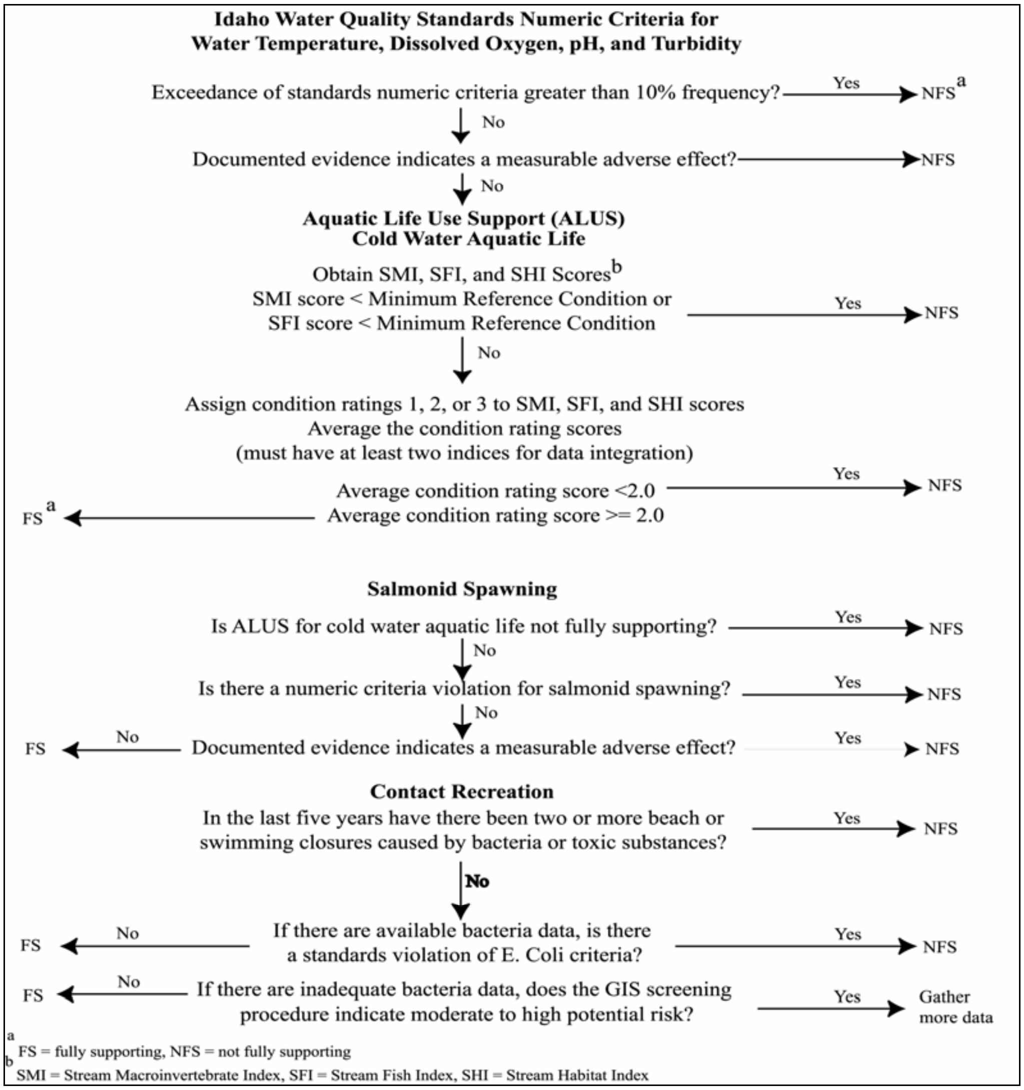

Figure 19. Determination Steps and Criteria for Determining Support Status of Beneficial Uses in Wadeable Streams: *Water Body Assessment Guidance*, Second Edition (Grafe *et al*. 2002).

2.3 Pollutant Beneficial Use Support Status Relationships

Sediment

Sediment is the most common non-point source pollutant in the state. The dominant portion of sediment loads in southern Idaho is suspended sediment. Many fish species can tolerate elevated suspended sediment levels for short periods of time, such as during natural spring runoff, but longer durations of exposure are detrimental.

Elevated suspended sediment levels can interfere with feeding behavior (difficulty finding food due to visual impairment), damage gills, reduce growth rates, smother eggs and fry in the substrate, damage habitat, and in extreme cases eventually lead to death. Eggs, fry, and juveniles are especially sensitive to suspended sediment.

By smothering fish spawning and rearing grounds, sedimentation leads to a homogenization of available habitats. Additionally, sediment reduces the available habitat for the food organisms of the fish, as well as smothering the food organisms themselves. Aquatic insects (macroinvertebrates), which serve as a primary food source for fish, are affected by excess sedimentation. Increased sedimentation leads to a macroinvertebrate community that is dominated by burrowing species, thereby making the macroinvertebrates less available to fish. Community structure, specifically diversity, of the aquatic macroinvertebrate community also diminishes due to the reduction of coarse substrate habitat.

In addition, increased sedimentation leads to a loss of juvenile rearing and over-wintering habitat. As water temperatures decline in the winter, juvenile salmonids seek interstitial spaces in the substrate where they become torpid. When sediment fills the interstitial spaces, it leaves the juvenile fish with no cover during this period of inactivity and makes them more vulnerable to predation (Georgia Conservancy 2004).

Newcombe and Jensen (1996) summarized 80 published reports on the effects of suspended sediments on fish in streams and estuaries. For rainbow trout, physiological stress, which includes reduced feeding rate, is evident at concentrations of 50 to 100 mg/L when those concentrations are maintained for 14 to 60 days. Suggested limits for suspended sediment were developed by the European Inland Fisheries Advisory Commission and the National Academy of Sciences and adopted by the state of Idaho in previous TMDLs. A limit of 25 mg/L *suspended sediment concentration* (SSC) would provide a high level of protection of the aquatic organisms, 80 mg/L SSC moderate protection, 400 mg/L SSC low protection, and over 400 mg/L SSC very low protection (Thurston et al. 1979).

Bedload sediment also impairs the beneficial uses of some streams in the subbasin. Bedload consists of sediment particles too large or heavy to be suspended, but still transported by flowing water along the streambed. As sand and silt wash downstream, they can cover spawning gravels, increasing embeddedness in the streambed. If this occurs during incubation periods or while small fry are using the spawning gravels to develop, it may eliminate those areas and result in death. Bedload can also reduce inter-gravel dissolved oxygen levels by decreasing the critical re-oxygenating flow through the inter-gravel matrix. Organic suspended sediments can also settle to the bottom and, due to their high carbon content, lead to low inter-gravel dissolved oxygen.

Sediment levels that exceed a stream's transport capacity often trigger stream morphology changes like excessive widening as the stream tries to stabilize. These processes themselves also result in accelerated erosion rates which further diminishes habitat diversity (i.e. pools, riffles) and impacts fisheries.

Sediments originating from the drainage basin are primarily *inorganic*, have a low carbon content, have high densities, and often increase in the water column during runoff events. Sediments originating instream (from primary production) are organic with a higher carbon content and lower density and often increase in association with algae blooms. The concentration of organic sediments can be underestimated because of their lower density.

Bedload sediment also adversely affects aquatic species, although the direct effects of bedload are difficult to gauge because bedload is largely a function of stream power, which is in most cases not a manageable condition. As sand and silt wash downstream, they can cover spawning gravels, increasing embeddedness in the streambed. If this occurs during incubation periods or while small fry are using the spawning gravels to develop, it may eliminate those areas and result in death. Bedload can also reduce intergravel dissolved oxygen (DO) levels by decreasing the critical re-oxygenating flow through the intergravel matrix.

As mentioned above, bedload is largely a function of stream power, which is driven by stream velocity. In smaller order water bodies, higher velocities are short duration events based on snow melt or storm events. Directly related to the size of the watershed, peaks in the hydrographs and base flow conditions can occur within a week of each other in smaller watersheds, with peak flows occur during a few days. While in the larger watersheds, peak flows and baseline flows may occur months apart, with peak flows lasting for weeks.

These short duration, high velocity flows may not offer the opportunity for complete removal of either the larger sediment particles or the smaller particles which may have entered the water body due to land use practice and/or natural erosion. The other consideration is the presence of fish that prefer slower velocities for refugia and spawning activity. Cold water species, such as trout prefer smaller tributaries for spawning, incubation and fry development, with rearing occurring in the larger water bodies.

Many studies have been conducted to determine the effects of sediments, both bedload and suspended, on cold water species. Suspended sediments or suspended solids usually affect sight-feeding capability, clogging of gills or related stress as mentioned above. Bedload sediment, especially fine sediment of less than 6 millimeters (mm) in diameter, can cause impairment of uses in a variety of ways. Bedload sediment can fill in gravels associated with salmonid spawning gravels, cover redds reducing intergravel dissolved oxygen levels, encase fry, fill in interstitial spaces required for fry development and salmonid food sources, reduce pool volume required for salmonid refugia areas, and cover substrate required for primary food (*periphyton*) production areas.

The particle size of the substrate directly affects the flow resistance of the channel, stability of the streambed, and the amount of aquatic habitat. If the substrate is composed of predominantly fines, then the spaces between the particles are too small to provide refuge for most organisms. The greatest number of species and thus the greatest diversity is found with a complex substrate of boulders, stone, gravels and sand. Coarse materials such as gravels provide a variety of small niches for juvenile fish and *benthic* invertebrates. Because salmonids have adapted to the natural size distributions of substrate materials, no single sized particle class will provide the optimum conditions for all life stages of salmonids. For spawning, a mix of gravel with a small amount of fine sediment and small rubble is optimal. When small fines (<6.35 mm) exceed 20-25% of the total substrate, embryo survival and emergence of swim-up fry is reduced by 50% (Bjornn and Reiser 1991).

Temperature

Temperature is a component of water quality integral to the life cycle of fish and other aquatic species. Different temperature regimes result in varying aquatic community compositions. Water temperature dictates whether a warm, cool, or cold water aquatic community is present. Many factors, natural and anthropogenic (human caused), affect stream temperatures. Natural factors include but are not limited to altitude, aspect, climate, weather, geothermal sources, riparian vegetation (shade), and channel morphology (width and depth). Anthropogenic factors include heated discharges (such as those from point sources), riparian alteration, channel alteration, and flow alteration.

Elevated stream temperatures can be harmful to fish at all life stages, especially if they occur in combination with other habitat limitations such4 as low dissolved oxygen or poor food supply. Temperature as a chronic stressor to adult fish can result in reduced body weight, reduced oxygen exchange, increased susceptibility to disease, and reduced reproductive capacity. A rise of 1 degree C increases the metabolic rate of cold blooded aquatic organisms by 10%. This means that aquatic organisms end up respiring more and eating more in warmer waters than in colder ones. Acutely high temperatures can result in death if they persist for an extended length of time. If stream temperatures become too hot, fish die almost instantaneously due to denaturing of critical enzymes in their bodies (Hogan 1970). Juvenile fish are even more sensitive to temperature variations than adult fish, and can experience negative impacts at a lower threshold value than the adults, manifesting in retarded growth rates. High temperatures also affect embryonic development of fish before they even emerge from the substrate.

The upper lethal limits for salmonids range from 23-29° C, depending upon species, with the optimal temperature range lying between 12-14° C. In larger Idaho streams where summer maximum temperatures are 24-26 ° C and minimum temperatures are relatively high (15-16°C), most young salmonids move into tributaries with lower temperatures (Bjornn and Reiser 1991).

Appendix G discusses the role of riparian vegetation, channel condition and streamflow in stream cooling in more detail.

Bacteria

Coliform bacteria are unicellular organisms found in feces of warm-blooded animals such as humans, domestic pets, livestock, and wildlife. Coliform bacteria are commonly monitored as part of point source discharge permits (*National Pollution Discharge Elimination System* [NPDES] permits), but may also be monitored in nonpoint source arenas. The human health effects from pathogenic coliform bacteria range from nausea, vomiting, diarrhea, acute respiratory illness, meningitis, ulceration of the intestines, and even death. Coliform bacteria do not have a known effect on aquatic life.

Coliform bacteria from both point and nonpoint sources impact water bodies, although point sources are typically permitted and offer some level of bacteria-reducing treatment prior to discharge. Nonpoint sources of bacteria are diffuse and difficult to characterize. Unfortunately, nonpoint sources often have the greatest impact on bacteria concentrations in water bodies. This is particularly the case in urban storm water, agricultural areas and where wildlife is abundant. Wildlife may account for a significant percentage of the bacteria in some water bodies, although the exact percentage is difficult to determine.

The state numeric standard for bacteria is < 126 *E. coli* organisms/100 mL as a 30 day geometric mean with a minimum of five samples AND no sample > 406 *E. coli* organisms/100 mL.

Excess Nutrients

IDAPA 58.01.02.200.06 states, "Surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses." Nutrients in excess quantities often cause rapid *eutrophication* of aquatic systems. The primary production in an aquatic system is often limited by the available concentration of one of these micronutrients (Brochardt 1996). In the western United States, phosphorus is typically the nutrient that has the greatest limiting effect on the production of aquatic plants and algae. Nitrogen (N) to phosphorus (P) ratios are often used to determine the *limiting factor* in aquatic vegetation production and biomass.

Other factors, such as light or available substrates also may limit production of aquatic macrophytes. The algae that grow on the stream and river substrates are called periphytic or benthic algae. They typically consist of single celled organisms called diatoms. These diatoms are the primary food source for many pollution intolerant aquatic macroinvertebrates that scrape the diatoms from the substrate. Sestonic forms of algae are free floating algae cells. They may be dislodged diatoms or other types of colonial algae organisms. If nutrients are in excess of the physiological needs of the diatom community, other less palatable forms of algae grow causing a reduction in the intolerant aquatic community. These less palatable forms include filamentous and colonial algae. In addition to being less palatable, these organisms are considered by some to be aesthetically unpleasing and are what typify nuisance aquatic growths.

The principal nutrients limiting aquatic plant growth in the Payette River watershed are nitrogen and *total phosphorus* (TP). While nutrients are a natural component of the aquatic ecosystem, natural cycles can be disrupted by increased nutrient inputs from anthropogenic activities. The excess nutrients result in accelerated plant growth and can result in a eutrophic or enriched system. The nuisance aquatic growth caused by this enrichment is discussed in the following section.

The first step in identifying a water body's response to nutrient flux is to define which of the critical nutrients is limiting. A limiting nutrient is one that normally is in short supply relative to biological needs. The relative quantity affects the rate of production of aquatic biomass. Either nutrient (phosphorus or nitrogen) may be the limiting factor for algal growth, although phosphorus is most commonly the limiting nutrient in Idaho waters. Ecologically speaking, a resource is considered limiting if the addition of that resource increases growth (IDEQ 2003).

Total phosphorus is the measurement of all forms of phosphorus in a water sample, including all inorganic and organic particulate and soluble forms. In freshwater systems, typically greater than 90% of the TP present occurs in organic forms as cellular constituents in the biota or adsorbed to particulate materials (Wetzel 1983). The remainder of phosphorus is mainly soluble *orthophosphate*, a more biologically available form of phosphorus that consequently leads to a more rapid growth of algae than TP. In impaired systems, a larger percentage of the TP fraction is comprised of orthophosphate.

Nitrogen to phosphorus ratios (N:P) in the North Fork Payette River showed that phosphorus was the limiting nutrient the majority of the time. N:P ratios greater than seven are indicative of a phosphorus-limited system while those ratios less than seven are indicative of a nitrogen-limited system. When nitrogen is limiting, additions of the nutrient can increase vegetation biomass theoretically by 70 times the molecular weight of the nutrient. In contrast, with phosphorus additions the increase is closer to a 500-fold increase in biomass (Wetzel 1975). Because of this, a reduction in phosphorus can reduce the aquatic vegetation to a greater extent than reductions in nitrogen.

Nutrients primarily cycle between the water column and sediment through nutrient spiraling. Aquatic plants rapidly assimilate dissolved nutrients, particularly orthophosphate. If sufficient nutrients are available in either the sediments or the water column, aquatic plants will store an abundance of such nutrients in excess of the plants' actual need, a chemical phenomenon known as *luxury consumption*. When a plant dies, the tissue decays in the water column and the nutrients stored within the plant biomass are either restored to the water column or the detritus becomes incorporated into the river sediment.

As a result of this process, nutrients (including orthophosphate) that are initially released into the water column in a dissolved form will eventually become incorporated into the river bottom sediment. They are then available once again for uptake by yet another life cycle of rooted aquatic macrophytes and other aquatic plants. This cycle is known as nutrient spiraling. Nutrient spiraling results in the availability of nutrients for later plant growth in higher concentrations downstream.

Floating, Suspended, or Submerged Matter (Nuisance Algae)

Algae are an important part of the aquatic food chain. However, when elevated levels of algae impact beneficial uses, those levels are considered nuisance aquatic growth. The excess growth of phytoplankton, periphyton, and/or macrophytes can adversely affect both aquatic life and recreational water uses. Algal blooms occur where adequate nutrients (nitrogen and/or phosphorus) are available to support growth. In addition to nutrient availability, velocities, water temperatures, and penetration of sunlight in the water column all affect algae (and macrophyte) growth. Low velocity conditions allow algae concentrations to increase because physical removal by scouring and abrasion does not readily occur. Increases in temperature and sunlight penetration also result in increased algae growth. When the aforementioned conditions are appropriate and nutrient concentrations exceed the quantities needed to support algae growth, excessive blooms may develop.

Algae blooms commonly appear as extensive layers or mats on the surface of the water. When present at excessive concentrations in the water column, blue-green algae often produce toxins that can result in skin irritation to swimmers, and illness or even death in animals ingesting the water. The toxic effect of blue-green algae is worse when an abundance of organisms die and accumulate in a central area. In 1993, 23 cows died after ingesting water from Cascade Reservoir that had high levels of blue green algae toxins.

Algae blooms also often create objectionable odors and coloration in domestic drinking water, and can produce intense coloration of both the water and shorelines as cells accumulate along the banks. In extreme cases, algae blooms can also result in impairment of agricultural water supplies due to toxicity. Water bodies with high nutrient concentrations that could potentially lead to a high level of algae growth are said to be eutrophic. The extent of the effect is dependent on both the type(s) of algae present and the size, extent, and timing of the bloom.

When algae die in low flow velocity areas, they sink slowly through the water column, eventually collecting on the bottom sediments. The biochemical processes that occur as the algae decompose remove oxygen from the surrounding water. Because most of the *decomposition* occurs within the lower levels of the water column, a large algae bloom can substantially deplete dissolved oxygen concentrations near the bottom. Low dissolved oxygen concentrations in these areas can lead to decreased fish habitat as fish will not frequent areas with low dissolved oxygen. Both living and dead (decomposing) algae can also affect the pH of the water due to the release of various acid and base compounds during *respiration* and photosynthesis. Additionally, low dissolved oxygen levels caused by decomposing organic matter can lead to changes in water chemistry and release of adsorbed phosphorus to the water column at the water/sediment interface.

Excess nutrient loading can be a water quality problem due to the direct relationship of high total phosphorus (TP) concentrations on excess algae growth within the water column, combined with the direct effect of the algal life cycle on dissolved oxygen and pH within aquatic systems. Therefore, the reduction of TP inputs to the system can act as a mechanism for water quality improvements, particularly in surface-water systems dominated by blue-green algae, which can acquire nitrogen directly from the atmosphere and the water column. Phosphorus management within these systems can potentially result in improvement in the following water quality parameters: nutrients (phosphorus), nuisance algae, dissolved oxygen and pH.

Sediment – Nutrient Relationship

The linkage between sediment and sediment-bound nutrients is important when dealing with nutrient enrichment problems in aquatic systems. Phosphorus is typically bound to particulate matter in aquatic systems and, thus, sediment can be a major source of phosphorus to rooted macrophytes and the water column. While most aquatic plants are able to absorb nutrients over the entire plant surface via a thin cuticle (Denny 1980), bottom sediments serve as the primary nutrient source for most sub-stratum attached macrophytes. The US Department of Agriculture (USDA 1999) determined that other than harvesting and chemical treatment, the best and most efficient method of controlling macrophyte growth is by reducing surface erosion and sedimentation.

Sediment acts as a nutrient sink under aerobic conditions. However, when conditions become anoxic, sediments can release phosphorous into the water column.

Sediments can play an integral role in reducing the frequency and duration of phytoplankton blooms in standing waters and large rivers (Robertson 1999). In many cases there is an immediate response in phytoplankton biomass when external sources are reduced. In other cases, the response time is slower, often taking years. Nonetheless, the relationship is important and must be addressed in waters where phytoplankton is in excess.

Dissolved Oxygen

Oxygen is necessary for the survival of most aquatic organisms and essential to stream purification. Dissolved oxygen (DO) is the concentration of free (not chemically combined) molecular oxygen (a gas) dissolved in water, usually expressed in milligrams per liter (mg/L), parts per million, or percent of saturation. While air contains approximately 20.9% oxygen gas by volume, the proportion of oxygen dissolved in water is about 35%, because nitrogen (the remainder) is less soluble in water. Oxygen is considered to be moderately soluble in water. A complex set of physical conditions that include atmospheric and hydrostatic pressure, turbulence, temperature, and salinity affect the solubility.

Dissolved oxygen levels of 6 mg/L and above are considered optimal for aquatic life. When DO levels fall below 6 mg/L, organisms are stressed, and if levels fall below 3 mg/L for a prolonged period, these organisms may die; oxygen levels that remain below 1-2 mg/L for a few hours can result in large fish kills. Dissolved oxygen levels below 1 mg/L are often referred to as hypoxic; anoxic conditions refer to those situations where there is no measurable DO.

Juvenile aquatic organisms are particularly susceptible to the effects of low DO due to their high metabolism and low mobility (they are unable to seek more oxygenated water). In addition, oxygen is necessary to help decompose organic matter in the water and bottom sediments. Dissolved oxygen reflects the health or the balance of the aquatic ecosystem. Oxygen is produced during photosynthesis and consumed during plant and animal respiration and decomposition. Oxygen enters water from photosynthesis and from the atmosphere. Where water is more turbulent (e.g., riffles, cascades), the oxygen exchange is greater due to the greater surface area of water coming into contact with air. The process of oxygen entering the water is called *aeration*.

Water bodies with significant aquatic plant communities can have significant DO fluctuations throughout the day. Oxygen sags will typically occur once photosynthesis stops at night and respiration/decomposition processes deplete DO concentrations in the water. Oxygen will start to increase again as photosynthesis resumes with the advent of daylight. In many cases excess aquatic plants can cause supersaturation, whereby DO levels may reach unusually high levels during the daylight hours.

Temperature, flow, nutrient loading, and channel alteration all impact the amount of DO in the water. Colder waters hold more DO than warmer waters. As flows decrease, the amount of aeration typically decreases and the in-stream temperature increases, resulting in decreased DO. Channels that have been altered to increase the effectiveness of conveying water often have fewer riffles and less aeration. Thus, these systems may show depressed levels of DO in comparison to levels before alteration. Nutrient enriched waters have a *higher biochemical oxygen demand* (BOD) due to the amount of oxygen required for organic matter decomposition and other chemical reactions. This oxygen demand results in lower in-stream DO.

2.4 Summary and Analysis of Existing Water Quality Data

The amount of available data varied substantially between subwatersheds. Types of available data also ranged widely, but typically represent biological, chemical, and physical parameters. Data pertinent to the water quality issues being addressed are presented for each listed stream in this section (Table 5). The subwatershed characteristics and water quality data for each 303(d) listed streams, and also for Squaw Creek are summarized by water body.

The North Fork Payette River and mainstem Payette River have several historic and current USGS gauge sites as well as nutrient and sediment information collected by BOR and DEQ. Data for tributary steams, however, is sparse. Neither flow nor water chemistry information is available for most streams tributary to the TMDL reach with the exception of the South Fork Payette River. Limited summer season monitoring was undertaken by DEQ at the initiation of the TMDL process. This information is augmented by assessments completed as part of DEQ's Beneficial Use Reconnaissance Program (BURP).

Table 5. Available Data for the North Fork Payette River TMDL.

Data Source	Type of Data	Sample Media	Years
Idaho Dept of Fish and Game	Fish Data	North Fork Payette River	Various Years
Idaho Dept. of Lands-Native Fish Advisory Group	Bull Trout Watershed Assessment	Smaller 2nd-3rd Order Water Bodies	2001
Idaho DEQ, Boise	Chemical and Bacteria Point Source Assessment	North Fork Payette River, Payette River and Point Source Effluent	Various Years
Idaho DEQ, Boise	Chemical, Biological, Temperature, DO, Bacteria	River (TMDL reach)	2002-2004
Idaho DEQ, Boise	Chemical, Biological, Temperature, DO, Bacteria	Upstream water quality (Cascade Reservoir Dam)	1989-2003
Idaho DEQ, Boise	Chemical, Biological, Temperature, DO, Bacteria	River (below Black Canyon Dam)	1999
US Bureau of Reclamation	Chemical, Biological, Temperature, DO, Bacteria	North Fork Payette River/Reservoir	Various Years
Idaho DEQ, BURP	Biological, Habitat, Erosion Inventories	Smaller 2nd-3rd Order Water Bodies	Various Years
US Fish and Wildlife Service	Bull Trout Recovery Plan		
US Forest Service	Fish Data-Bull Trout, Temperature Data	Smaller 2nd-3rd Order Water Bodies	Various Years
USGS	Chemical, Flows, Biological, Bacteria, Physical	River, Some Tributaries	Various Years

Data Assessment Methods

Several primary methods were used to evaluate the data for this subbasin assessment. A detailed description of the primary methods is located in Appendix G. A brief description of each method is located below.

DEQ-Water Body Assessment Guidance – Second Edition (Grafe et al. 2002)

The Water Body Assessment Guidance (WBAG) describes DEQ's methods used to consistently evaluate data and determine the beneficial use support status of Idaho water bodies. The WBAG is not used to determine pollutant-specific impairment. Rather, it utilizes a multi-index approach to determine overall stream support status. The methodology addresses many reporting requirements of state and federal rules, regulations, and policies.

For the most part, DEQ Beneficial Use Reconnaissance Program (BURP) data are used in the assessment. The BURP program utilizes standardized procedures to collect aquatic insects, conduct fish surveys, measure water chemistry and document habitat conditions in streams and rivers. The surveys take place during the summer months.

In addition to BURP information, where available, other data are integrated into the assessment process. An assessment entails analyzing and integrating multiple types of water body data, such as biological, physical/chemical, and landscape data, to address multiple objectives. The objectives are as follows:

1. Determine beneficial use support status of the water body (i.e., fully supporting versus *not fully supporting*).
2. Determine biological integrity using biological information or other measures.
3. Compile descriptive information about the water body and data used in the assessment.

The multi-metric index approach measures biological, *physiochemical*, and physical habitat conditions within a stream. The indexes include several characteristics to gauge overall stream health. Three primary indexes are used, which include the *Stream Macroinvertebrate Index (SMI)*, the *Stream Fish Index (SFI*) and the *Stream Habitat Index (SHI)*. The SMI is a direct measure of cold water aquatic life health. The SFI is also a direct measure of cold water aquatic life health, but is specific to fish populations. The SHI is used to measure instream habitat suitability, although some of the measurements used to generate the SHI are linked to the riparian area.

A few of the habitat parameters measured by both the BURP *protocol* and also by US Forest Service and Idaho Fish and Game studies are briefly described below.

Width Depth Ratio

Width-to-depth ratio (W:D) provides a dimensionless index of channel morphology, and can be an indicator of change in the relative balance between sediment load and sediment transport capacity (MacDonald and others 1991). Large width to depth ratios are often a result of lateral bank excursion due to increased peak flows, sedimentation, and eroding banks (Overton et al. 1995). Aberrant width depth ratios can cause reduced pool numbers (Beschta and Platts 1986), increased stream temperature, increased bank erosion and thus direct sediment delivery, decreased riparian vegetation and associated diminished ability of riparian area to capture nutrients and sediment (MacDonald et al. 1991). In the Idaho batholith, width:depth ratios of <10 are not common in even wilderness streams (Overton et al. 1995).

Bank Stability

Bank stability is rated by observing existing or potential detachment of soil from upper and lower streambanks and its potential movement into the stream. Measurements of bank angle and bank height may also be taken. Generally, steeper banks are more subject to erosion and correspondingly streams with largely unstable banks will often have poor instream habitat. Eroding banks can result in sedimentation, excessively wide streams, decreased depth and lack of vegetative cover. Banks that are protected by plant root systems or boulder/rock material are less susceptible to erosion.

Surface Fines

Surface fines can impair benthic species and fisheries by limiting the interstitial space for protection and suitable substrate for nest or redd construction. Certain primary food sources for fish (Ephemeroptera, Plecoptera, and Tricoptera macroinvertebrate species [EPT]) respond positively to a gravel to cobble substrate (Waters 1995). Substrate surface fine targets are difficult to establish. However, as described by Relyea, Minshall, and Danehy (2000), macroinvertebrate (Plecoptera) intolerant to sediment are mostly found where substrate fines (<6mm) is less than 30%. More sediment tolerant macroinvertebrates are found where the substrate cover (<6mm) is greater than 30%. Work by Overton (1995) refines the surface fine targets even more by defining conditions found in pristine streams. This information is used when available for interpreting percent fines numbers.

Cumulative Watershed Effects (CWE) Assessment Methodology

Idaho Code Section 38-1303 (17) defines cumulative watershed effects as ". . .*the impact on water quality and/or beneficial uses which result from the incremental impact of two (2) or more forest practices. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time*." The CWE methodology is designed, first, to examine conditions in the forest watershed surrounding a stream, and then in the stream itself. It then attempts to identify the causes of any adverse conditions. Finally, it helps to identify actions that will correct any identified adverse conditions. The CWE process is utilized for identifying general watershed problems and not as readily for estimating existing loads (quantities) of pollutants.

The CWE process consists of seven specific assessments:
A) Erosion and Mass Failure Hazards
B) Canopy Closure/Stream Temperature
C) Channel Stability
D) Hydrologic Risks
E) Sediment Delivery
F) Nutrients, and
G) Beneficial Uses/Fine Sediment

Streambank Erosion Inventory

The streambank erosion inventory was used to estimate background and existing streambank and channel erosion in streams where excess sediment was determined to be primarily generated from instream channel erosion. The inventory follows methods outlined in the proceedings from the *Natural Resource Conservation Service* (NRCS) Channel Evaluation Workshop (1983). The NRCS streambank erosion inventory is a field-based method that measures bank and channel characteristics such as stability, length of eroding banks, and depth of eroding banks to calculate a long-term lateral recession rate, expressed in terms of the feet of streambank lost due to erosion per year (ft/year). The lateral recession rate can then be combined with the volumetric mass of the bank material and the length of the segment to determine the sediment load from the streambanks.

BOISED

BOISED, a version of the Forest Service R1-R4 empirical sediment yield prediction model (WATSED), was developed to predict watershed scale responses to disturbance in the Boise and Payette National Forests for watersheds associated with the Idaho Batholith. Based on locally derived empirical streamflow and sediment yield data, BOISED uses stand properties and landscape units defined in terms of landform, lithology, and soil characteristics. Onsite surface and mass erosion estimates are adjusted for slope delivery based on topographic conditions, and downstream sediment delivery is adjusted on the basis of a watershed sediment delivery ratio. The model is sensitive to forest cutting and soil disturbance activities, including silvicultural practices, road construction practices, and wildfire.

Evaluation of Intermittence for Selected Streams

The state of Idaho defines an intermittent stream as one that has a period of zero flow for at least one week during most years or has a 7Q2 (a measure of the annual minimum 7-day mean stream flow, based on a 2-year low) hydrologically based flow of less than 0.10 cfs (IDAPA 58.01.02.003.51). If a stream contains naturally perennial pools with significant aquatic life, it is not considered intermittent. The implication of this determination is that TMDLs with the intent of restoring local (in the intermittent segment) beneficial uses will not be performed for these stream segments because water is not present during the critical loading period (typically the growing season) or when aquatic life beneficial uses are expected to be fully supported based on life cycle (middle to late summer months). IDAPA 58.01.02.070.07 states that water quality standards shall only apply to intermittent waters during optimum flow periods sufficient enough to support the beneficial uses for which the water body has been designated. The optimum flow for contact recreation is equal to or greater than 5.0 cfs. The optimum flow for aquatic life is equal to or greater than 1.0 cfs. However, TMDLs developed for downstream, perennial segments may apply to these segments because of their potential to contribute pollutants when water is flowing. For example, if an intermittent segment is typified by unstable, eroding banks due to anthropogenic causes, the load created during flow periods would be subject to a TMDL.

TMDL Target Analysis

The following is a discussion of targets selected for this TMDL. Table 6 shows the numerical targets used in evaluating pollutant impairment in specific 303 (d) listed water bodies. Some of the water bodies met the TMDL targets and thus a TMDL was not developed for the pollutant (i.e. nutrients and oil/grease for Black Canyon Reservoir).

However, the targets were used to evaluate beneficial use impairment. For streams that have TMDLs developed, those TMDLs are based on the targets listed for the particular pollutant.

Table 6. TMDL Water Body Specific Targets.

Water Body	Pollutant	Target	TMDL Completed
Black Canyon Reservoir	Nutrients Sediment Oil and Grease	0.025 mg/L total phosphorus/ 10 mg/L chlorophyll-*a* Tributary loading target of 25 mg/L seasonal average suspended sediment 5 mg/L oil and grease	No TMDLs completed
North Fork Payette River	Nutrients Sediment Temperature	0.1 mg/L total phosphorus 25 mg/L seasonal average suspended sediment/80% bank stability 19 degree Celsius average daily maximum temperature (surrogate target= 10% shade) Natural Background Conditions. When natural background conditions exceed the temperature criteria, the temperature criteria will not apply; instead, pollutant levels shall not exceed the natural background conditions.	No TMDL completed TMDL for sediment No TMDL completed
Box Creek Fall Creek	Temperature	9 degree Celsius average daily maximum temperature Natural Background Conditions. When natural background conditions exceed the temperature criteria, the temperature criteria will not apply; instead, pollutant levels shall not exceed the natural background conditions. Box Creek surrogate target: 82% vegetative cover -shade or 1.15 kwh/m^2/day Fall Creek surrogate target: 85% vegetative cover-shade or 0.957 kWh/m^2/day	TMDL completed TMDL completed
Round Valley Creek, Clear Creek, Big Creek, Tripod Creek, Soldier Creek	Sediment	80% bank stability (surrogate for sediment) For the upper and middle reach of Clear Creek: 12% above natural background BOISED modeled sediment delivery (surrogate for sediment)	TMDLs completed for Round Valley, Clear Creek, Big Creek No TMDL for Tripod or Soldier Creeks

Temperature

Temperature targets were based on numeric standards as shown in Table. In order to evaluate the North Fork Payette River from Clear Creek to Smiths Ferry, Box Creek and Fall Creek, potential vegetative canopy cover was used to develop shade targets as a surrogate for temperature. By using shade as a target, that means that as shade is increased, the amount of solar radiation reaching the stream and heating up the water is decreased. The effective shade surrogates address both the size of shade-producing features and stream width, thus entirely addressing solar radiation received by streams.

It is assumed that a stream that meets its potential natural vegetation condition would meet the water quality criteria unless background conditions or flow alteration preclude this attainment. The rules regarding natural background conditions state that when natural background conditions exceed any applicable water quality criteria set forth in Sections 210, 250, 251, 252, or 253, the applicable water quality criteria shall not apply; instead, pollutant levels shall not exceed the natural background conditions. Exceptions to this rule may occur in relation to point source discharges. However, there are no point source discharges in the 303(d)listed stream reaches. Shading targets were estimated from shade curves for existing TMDLs that represented similar vegetative types. Shade curves are graphically plotted as % effective shade on the vertical axis versus near stream width on the horizontal axis. As a stream becomes wider, a given vegetation type loses its ability to shade wider and wider streams and thus the shading % number becomes lower. Using a combination of measured and estimated channel width, vegetative communities and the directional aspect for these water bodies, the percent effective shade or the solar radiation loading was estimated using information generated from shade curves from existing TMDLs. Shade results for a grand fir/Douglas fir community were averaged for each stream's average width from Northern California's Mattole (CRWQCB 2002), Oregon's Walla Walla (ODEQ 2004a) and Willamette (ODEQ 2004b) TMDLs and Idaho's South Fork Clearwater TMDL (IDEQ 2002). The TMDL shade curves for these TMDLs were fairly similar. Specifics on the potential vegetative types used are presented in the following water quality data sections for each of these water bodies.

Stream widths for Fall and Box Creek were obtained from pre and post Blackwell Fire BURP data (1994 and 2003). This information showed that channel width did not change significantly due to the fire. River widths were measured at mile intervals on the North Fork Payette River during summer 2004.

Shade is defined as the percent reduction of potential direct beam solar radiation load delivered to the water surface. Thus, the role of effective shade in this TMDL is to prevent or reduce heating by solar radiation. Because effective shade is a measure of energy, a load can be directly calculated from this value.

Nutrients/Chlorophyll-a

The state of Idaho has narrative criteria for nutrients. A narrative standard for nutrients is appropriate given that the associated problems (excessive growth, low dissolved oxygen, etc.) can occur under a range of concentrations and are related to system characteristics such as flow, temperature, water column mixing, light penetration and water depth. Interpretation of the narrative standard on a site-specific basis is necessary to identify targets that will be protective of designated beneficial uses within the listed segment. Targets for Black Canyon Reservoir are based on chlorophyll-*a* and total phosphorus which are linked both directly and indirectly to beneficial use impairment. For example, indirect beneficial use impairment presents itself as low dissolved oxygen (DO) and high pH at or above these chlorophyll *a* levels. Beneficial use impairment is directly linked to the chlorophyll *a* indicators during nuisance algal blooms. EPA also suggests that chlorophyll-*a* is a desired endpoint because it can usually be correlated to loading conditions. Chlorophyll-*a* is the essential photosynthetic pigment found in aquatic plants. This TMDL utilizes the targets selected for the Cascade Reservoir TMDL because Black Canyon Reservoir is in the watershed directly downstream of the Cascade watershed. The Cascade Reservoir TMDL upstream of Black Canyon Reservoir used a 10 µg/L mean growing season chlorophyll- *a* target. The growing season is defined as the period from April through September.

Recently developed, EPA ecoregional reference criteria showed a 25th percentile reference concentration of 4.7 µg/L chlorophyll-*a* for lakes and reservoirs in this ecoregion (EPA 2000a).

While no state of Idaho standards exist for the numeric value of excess nutrients (phosphorus in this case), EPA has suggested guidelines to determine when phosphorus is in excess. General guidelines from 1986 suggested that to prevent the development of a biological nuisance and to control accelerated *cultural eutrophication*, total phosphorus (TP) on a monthly average should not exceed 0.05 milligrams per liter (mg/L) in streams that enter a lake or reservoir (EPA 1986). This target was used for the Payette River at Montour Bridge where the river flows into the reservoir to determine of nutrient loading was in excess of assimilative capacity. The EPA also suggested that TP on a monthly average not exceed 0.1 mg/L in any stream or other flowing water (EPA 1986). In reservoirs this guideline was set at 0.025 mg/L TP. These guidelines were used in the Cascade Reservoir TMDL (IDEQ 1996) and the efficacy of these guidelines was evaluated by reservoir modeling.

The 2000 EPA Ambient Water Quality Criteria Recommendations in Nutrient Ecoregion III (Xeric West) for both rivers and streams, and lakes and reservoirs reported sub-ecoregion 12 (Snake River Basin) reference conditions for total phosphorus in lakes and reservoirs to be 0.02 mg/L. This TMDL uses the 0.025 mg/L TP guideline because of the run-of-the-river characteristics of Black Canyon Reservoir and the utilization of this target for Cascade Reservoir (IDEQ, 1996). In other words, a retention time of 7-15 days results in Black Canyon Reservoir acting more like a river than a lake and nutrients tend to be transported through the system before they're utilized by aquatic plants. The 0.025 mg/L TP target is also assumed to be in the range of allowable conditions set by the ecoregional nutrient criteria.

The NFPR SBA and TMDL will use both chlorophyll *a* indicator guidelines and the EPA TP concentration guidelines to determine if beneficial use impairment has occurred. Black Canyon Reservoir is assessed using the 0.025 mg/L TP monthly average and the 10 µg/L chlorophyll *a* indicator. A comparison to EPA ecoregional criteria is also made. The rationale for this dual indicator is that elevated nutrient concentrations do not link directly to beneficial use impairment unlike chlorophyll-*a*. Other measures used to corroborate nutrient problems in these streams, such as low DO and elevated pH are also investigated.

Water Column Sediment Targets for the North Fork Payette River

As shown in Table 12 (page 109), the standard for sediment is narrative. The standard says "*sediment shall not exceed quantities specified in general surface water quality criteria (IDAPA 58.01.02.250 or 252) or, in the absence of specific sediment criteria, quantities which impair designated beneficial uses*." Since no specific sediment criteria exist for the North Fork Payette River, surrogate targets are used. Surrogates can be defined as alternative, numeric measures to narrative water quality standards. The surrogate targets are specifically designed to be protective of the designated aquatic life beneficial use (cold water aquatic life).

The acute criterion targets were first developed as part of the Lower Boise River sediment TMDL (IDEQ 1999) and are based on the extensive work of Newcombe and Jensen (1996). Newcombe and Jensen evaluated 80 published and adequately documented reports on fish response to suspended sediment concentration (SSC) in streams.

The result of their work was several species and age-specific dose-response matrices showing the expected effects of SSC on different species and ages of fish over different periods of exposure (duration). Using this concept, the durational targets shown below were developed (IDEQ 1999). The targets are designed to account for both chronic and acute exposure to excess water column sediment. The short-term target allows for natural variability due to storm and seasonal runoff events.

- a seasonal target of 25 mg/L suspended sediment
- a geometric mean of 50 mg/L suspended sediment for no longer than 30 consecutive days
- a geometric mean of 80 mg/L suspended sediment for no longer than 10 consecutive days

The targets shown above are expressed in terms of suspended sediment concentration. SSC is a protective (of aquatic life) measure of water column sediment because the laboratory analysis for SSC has the finite ability to capture sand size and smaller particles in the water column. These sized particles can be particularly dangerous to fish when in excess.

Oil and Grease

In 1976, EPA produced the "Red Book" of national water quality criteria (EPA 1976) with the following criteria recommendations for oil and grease:

> For domestic water supply: Virtually free from oil and grease, particularly from the tastes and odors that emanate from petroleum products.
>
> For aquatic life:
> (1) 0.01 of the lowest continuous flow 96-hour LC50 (LC=lethal concentration) to several important freshwater and marine species, each having a demonstrated high susceptibility to oils and petrochemicals.
> (2) Levels of oils or petrochemicals in the sediment which cause deleterious effects to the biota should not be allowed.
> (3) Surface waters shall be virtually free from floating nonpetroleum oils of vegetable or animal origin, as well as petroleum-derived oils.

These same recommendations were repeated in EPA's "Gold Book" of quality criteria for water (EPA, 1986). Texts in these documents warn that petroleum products are very harmful to aquatic life. EPA indicates that sublethal effects are reported at concentrations from 10 to 100 µg/L (.01-0.1 mg/L). This wide range of criteria recommendations is because toxicity of oil and grease pollutants can be highly variable, depending upon whether the oil and grease is from petroleum products or animal or vegetable oils.

New analytical methods for measuring oil and grease and *non-polar material* (NPM) were adopted by EPA in 1999 (EPA 1999b). The method detection limit (MDL) cited by EPA for these methods is 1.4 mg/L and the minimum level of quantification (ML) is 5 mg/L. However, the Idaho State Bureau of Laboratories has established a MDL of 1 mg/L for Method 1664 and a ML of 1 mg/L.

Several states (WY, IN) and EPA Region 3 have used an oil and grease numerical criterion in their water quality standards of 10 mg/L (Buening 2001; EPA 2003; Wyoming Water Quality Standards, Chapter 1). This value is derived from the concentration where oil sheens or films do not appear on surface waters (EPA, 2003).

The Portneuf River TMDL in southeast Idaho used a 5 mg/L target for its oil and grease TMDL. In this case, DEQ looked to surrounding states for a numerical target and found Wyoming's 10 mg/L standard. DEQ then halved that value because, 1) it provides a margin of safety, and 2) sets the target at EPA's minimum quantification level (ML).

EPA's criteria documents and the NPS evaluation show that petroleum products can be harmful to aquatic life at levels well below 1 mg/L. But, it is also evident that oil and grease can be made of compounds, including animal and vegetable oils, that are not necessarily harmful to humans or aquatic life. In the past, higher targets have been used to address the aesthetic concerns of oil and grease, meaning standards have been developed at the much higher 10 mg/L level to avoid producing visible sheen while not necessarily being entirely protective of aquatic life.

For this TMDL, an average concentration of 5 mg/L will be used because this target level is both conservative and accounts for chronic toxic effects to aquatic life.

Streambank Erosion Inventory

The streambank inventory was used to estimate background and existing streambank and channel erosion in streams where excess sediment was determined to be primarily generated from instream channel erosion. The streams inventoried included Big Creek, Clear Creek, Fall Creek, Round Valley Creek, Soldier Creek and Tripod Creek. Some streams received a more cursory inventory than others once overall bank stability was determined to be high.

The inventory follows methods outlined in the proceedings from the Natural Resource Conservation Service (NRCS) Channel Evaluation Workshop (1983). The NRCS streambank erosion inventory is a field-based method that measures bank and channel characteristics such as stability, length of eroding banks, and depth of eroding banks to calculate a long-term lateral recession rate, expressed in terms of the feet of streambank lost due to erosion per year (ft/year). The lateral recession rate can then be combined with the volumetric mass of the bank material and the length of the segment to determine the sediment load from the streambanks.

Streambank erosion inventories are linked to bank stability, which is used as a surrogate for instream particle size distributions. Previous TMDLs (IDEQ 2001a, 2001b, 2003) have established a linkage between 80% streambank stability and less than 30% fine substrate material in riffles. This linkage allows for the restoration of beneficial uses to be assessed based on bank stability (i.e. streams with >80% bank stability will likely support cold water aquatic life beneficial uses). Of course, this linkage is based on sediment related use impairment only. If factors other than excess sediment are impairing uses, this method will not detect them and they must be addressed elsewhere.

For this TMDL, DEQ staff calculated the streambank erosion rates of stream types where banks are expected to be greater than 80% stable and the particle size distribution in riffles is expected to contain less than 30% fines (particles <6.0 mm in diameter) or more specifically the Overton (1995) mean reference condition for percent fines defined for that stream Rosgen type and geology. These erosion rates are then used as reference rates for similar morphological channel types on the §303(d) listed streams where banks are eroding and fine materials exceed 30% in riffles. The reference rates become the benchmark for the impaired stream and thus, the basis of load reductions.

BOISED Targets

BOISED was not developed specifically for TMDL analysis, and while not designed to predict absolute quantities of sediment delivered to a water body at a specific time, the model does produce quantified estimates of average annual sediment yield. However, for Clear Creek, the BOISED information currently provides the most comprehensive estimate of sediment delivery from roads and BOISED modeling done in the upper and middle reaches of Clear Creek is used for determining sediment allocations. The target selected is based on sediment delivery results for a watershed that has percent surface fines similar to that of streams in undisturbed watersheds. This target of 12% over natural background sediment delivery was then applied throughout the modeled watershed and used to determine an allocation based upon sediment delivery rate. This target links to an amount of surface fines indicative of no impairment.

Like all models, BOISED has a higher degree of sensitivity for some parts of the analysis than for others. BOISED is used by the Forest Service to determine the different sediment delivery rates over natural background presented by different timber management scenarios. Since road construction can result in significant sediment inputs to streams depending upon type of road constructed and location, BOISED is often used to evaluate road construction alternatives. BOISED does not examine the effects of management activities on landslides nor does it incorporate increases to sediment loads due to fire, range, or agricultural activities. The estimates provided by these models are based on current sediment sources during average climatic conditions. DEQ chose a very conservative target to account for the uncertainty in the model.

North Fork Payette River

General North Fork Payette River subwatershed characteristics are covered in the Sub-basin Characteristics section, Section 1.2.

The North Fork Payette River from Clear Creek to Banks is in the Southern Forested Mountains ecoregion of the Idaho Batholith (McGrath et al., 2001). Open Douglas fir (*Psuedotsuga menziesii*) forests are common with grand fir (*Abies grandis*) and subalpine fir (*Abies lasiocarpa*) at higher elevations and Ponderosa pine (*Pinus ponderosa*) predominant in canyons.

From Banks to Black Canyon Reservoir, the landscape becomes markedly more arid as the river drops in elevation and moves into areas of Columbia River basalt.

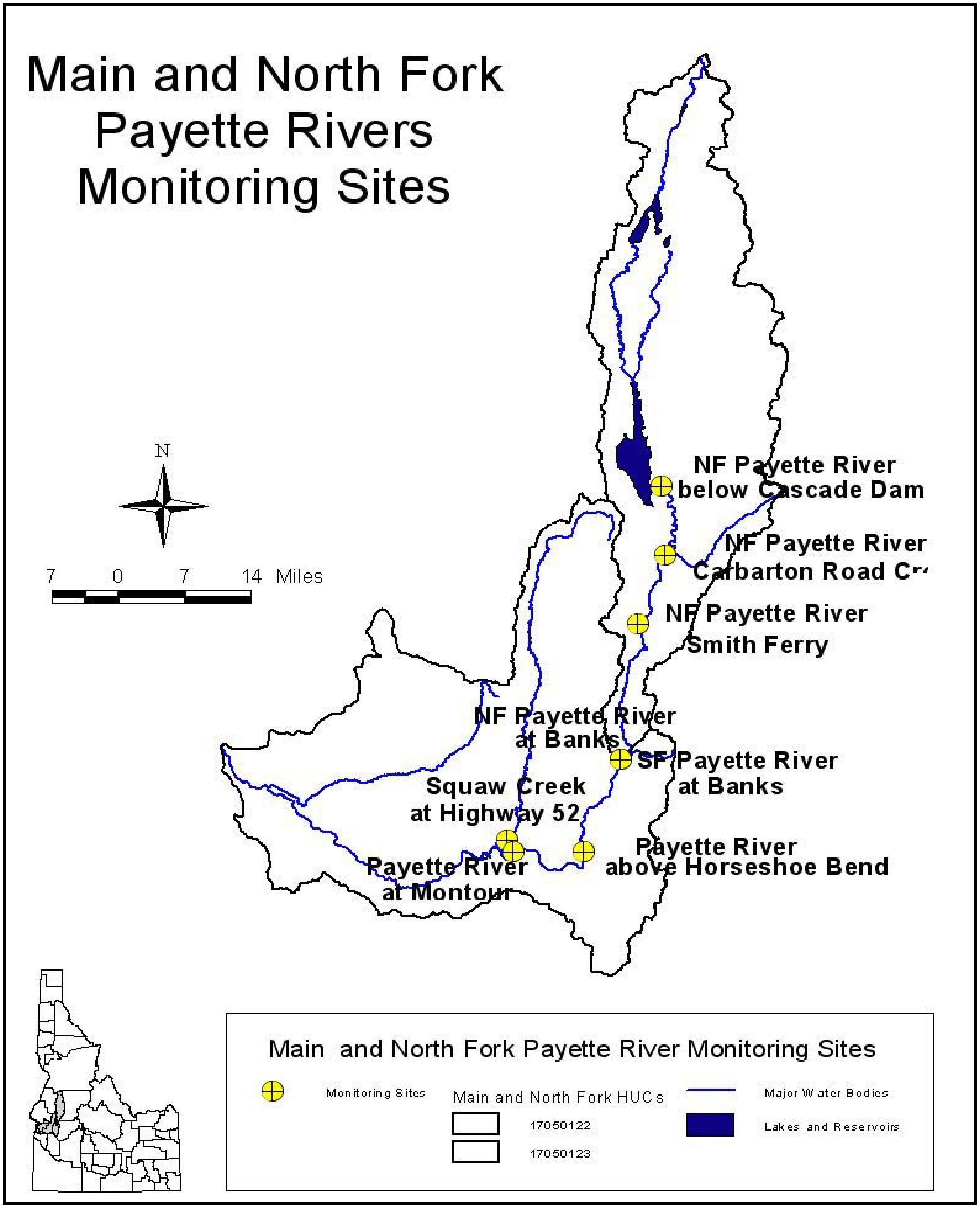

Figure 20. Main and North Fork Payette River Monitoring Sites.

Flow Characteristics

The North Fork Payette River is a hydrologically modified system with flow largely influenced by outflow from Cascade Dam and in the lower reach, inflow from the South Fork Payette River. Peak flow usually occurs in late May and June from both snowmelt runoff and release of water from Lake Cascade after the reservoir fills (Figures 21 and 22). The average annual runoff at Horseshoe Bend is about 2.35 million acre-feet of water per year. Base flow is usually in November. If the system were not hydrologically modified, base flows would probably occur in August. Prior to the reservoir filling, releases in winter and spring are generally around 200 cubic feet per second (cfs). The BOR informally operates Cascade and Deadwood to try and keep maximum flows below 12,000 cfs at the Horseshoe Bend gauge. During the summer months, flows are generally kept at between 2,100-2,600 cfs at the Horseshoe Bend gauge in order to meet the needs of downstream irrigators. Dam releases are from Cascade and Deadwood Reservoirs.

The floods of early 1997 changed the characteristics of some of the rapids as well as created a new class III rapid on the Main Payette due to landslides that dumped large amounts of debris into the river. As shown in Figure 23, rain-on-snow events caused flows to spike to almost 20,000 cfs around New Years day and then flows remained unseasonably high during January and February.

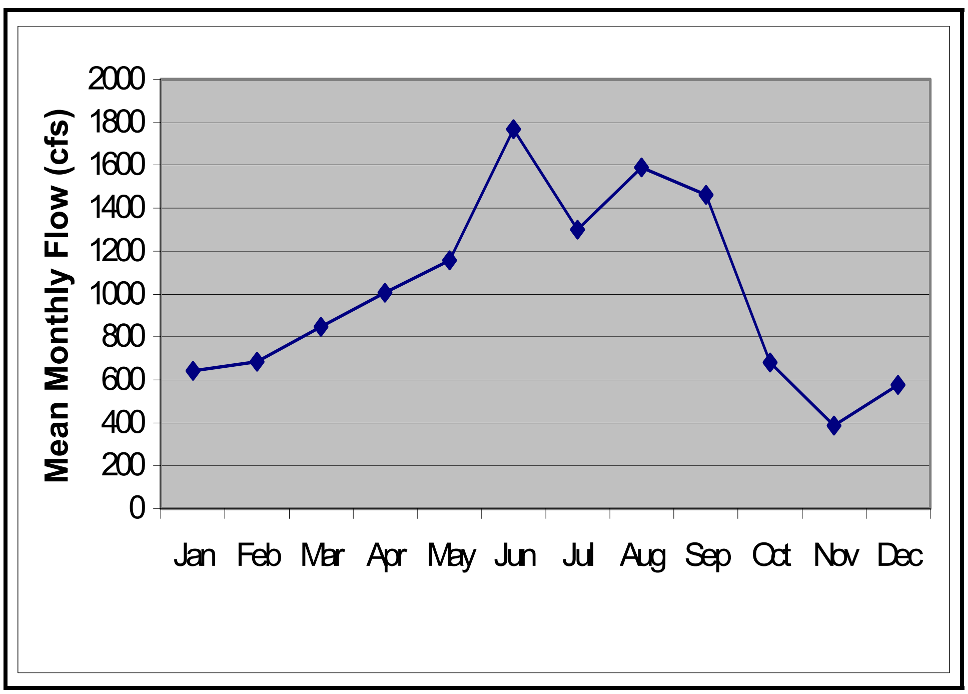

Figure 21. North Fork Payette River Average Monthly Flows at Cascade Reservoir Dam: 1980-2002.

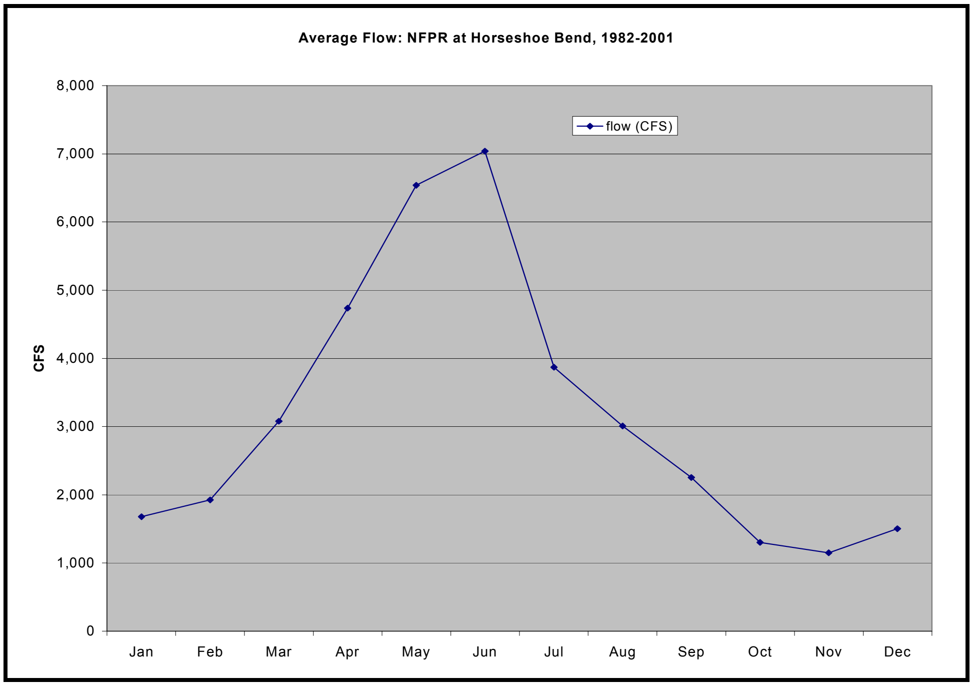

Figure 22. Average Flow: NFPR at Horseshoe Bend.

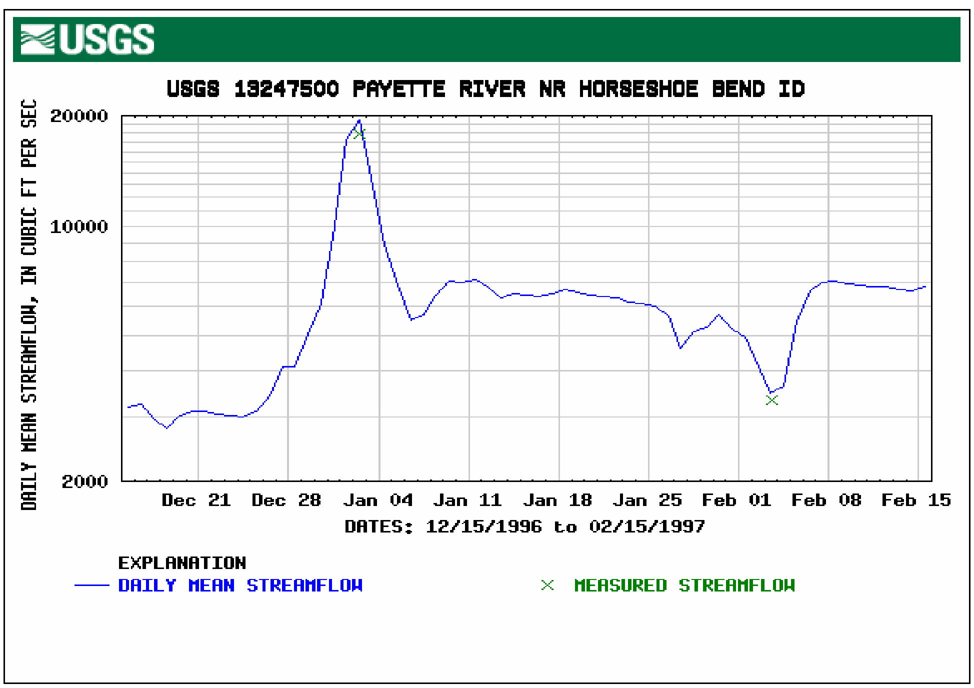

Figure 23. Daily Mean Streamflow: NFPR Winter 1996-97.

Water Column Data

DEQ started collecting monthly water quality data in October 2002, on the North Fork and Main Payette River at stations located at Cascade Reservoir dam (CRD), the Cabarton Bridge south of Cascade (CB), the Smith's Ferry Bridge east of Highway 55 (SFB), the Highway 55

Bridge at Banks (BB), the Gardena Bridge west of Highway 55 (GB), near the Mill Pond intake pump at Horseshoe Bend (HSB), and the Montour Bridge south of Highway 52 (MB). In 2004, DEQ dropped the Gardena Bridge site, but started monitoring Squaw Creek, the mouth of the South Fork Payette River and Black Canyon Reservoir (Figure 20). Figures 23-30 display DEQ data.

Nutrients: North Fork Payette River: Cascade Dam to Smiths Ferry

While there is aquatic plant growth in slow moving areas of the river, impairment to fisheries or recreation is not evident. Total phosphorus concentrations in the river at Smiths Ferry were less than 0.1 mg/L for all sampling events (Figure 24) which is below the EPA Gold Book target and also the Cascade Reservoir TMDL target of 0.1 mg/L for a river that discharges into another river (the North Fork Payette River discharges into the Main Payette River). The total phosphorus concentrations averaged 0.04 mg/L from April to September and 0.04 mg/L for the entire 2003 sampling season as shown in Figure 25. These concentrations were also below the 0.05 mg/L Cascade Reservoir TMDL and 1986 EPA Gold Book recommended criterion for total phosphorus for rivers that drain directly into reservoirs. The 2004 April to September data showed a 0.058 mg/L average total phosphorus concentration and 0.05 mg/L median total phosphorus concentration. Averaging the monthly data together for the 2003 and 2004 water years resulted in an annual average of 0.047 mg/L and an April to September average of 0.047 mg/L.

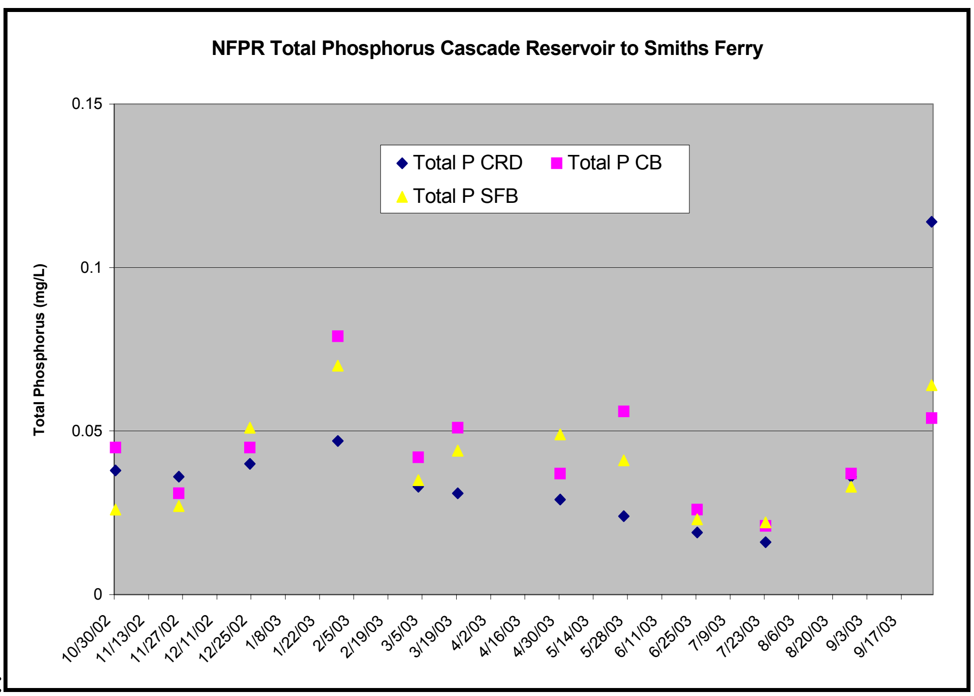

Figure 24. Total Phosphorus Measurements: NFPR 2003.

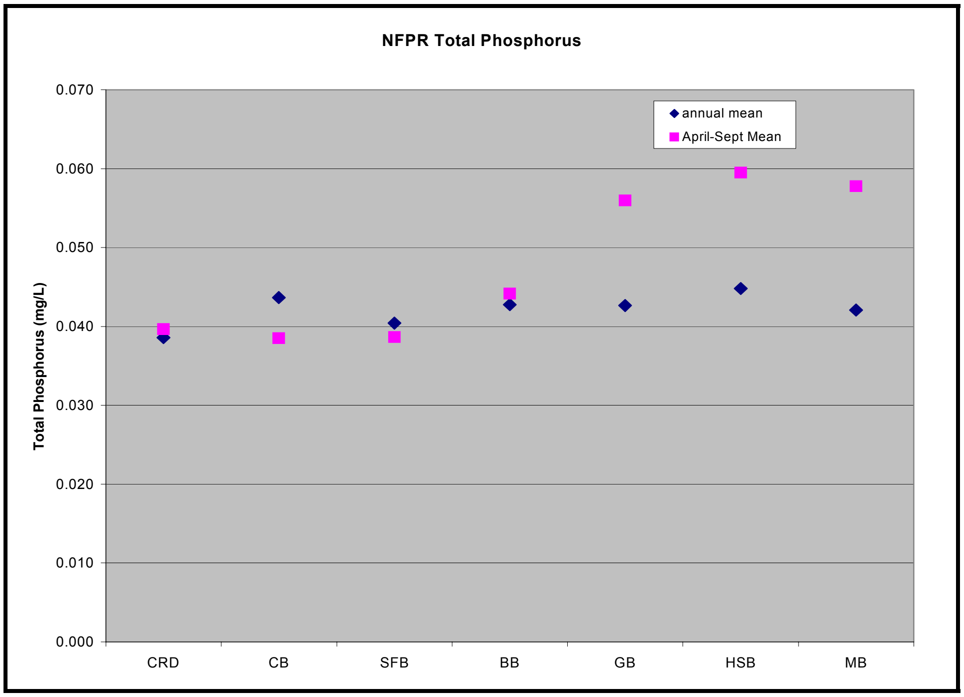

Figure 25. 2003 Total Phosphorus Annual Mean and April-September Mean Concentrations.

Dissolved Oxygen

As shown in Figure 26, dissolved oxygen levels were generally above the standard of 6 mg/L with the exception of July, when dissolved oxygen levels in the water released from Cascade were below 6 mg/L. However, specific standards exist for waters discharged from dams, reservoirs, and hydroelectric facilities and the standard was not violated. Idaho Power records show that in the river, below the dam, dissolved oxygen levels were below 6 mg/L, 21 days out of 31 during July. Blowers, in place to help oxygenate the water, were activated for at least 12 of those days. The state water quality standards states that between June 15–October 15, the 30 day minimum shall be 6 mg/L or greater, the instantaneous minimum 3.5 mg/L or greater and the 7 day mean minimum shall be 4.7 mg/L or greater. Dissolved oxygen concentrations met these criteria during this time. Dissolved oxygen concentrations at Smiths Ferry remained above 6 mg/L for the entire sampling season.

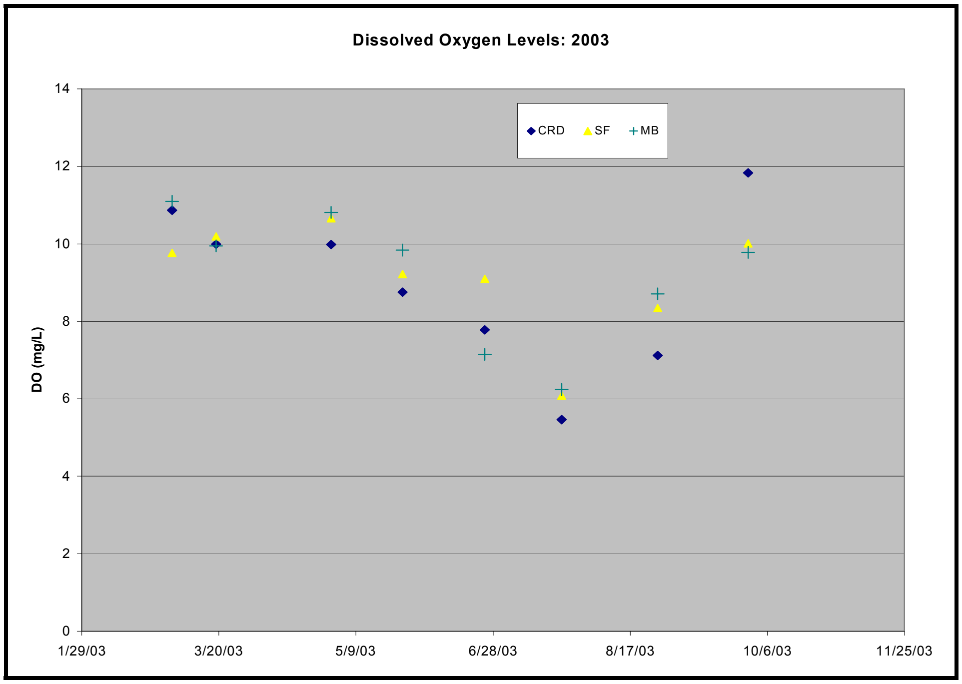

Figure 26. Dissolved Oxygen Levels: 2003 Sampling Season.

Sediment: Cascade Dam to Smiths Ferry

Total suspended sediment concentrations were well below the 25 mg/L target and the 50 mg/L monthly average concentration recommended by the European Inland Fisheries Advisory Commission and the National Academy of Sciences and adopted by the state of Idaho in previous TMDLs (Figures 27 and 28).

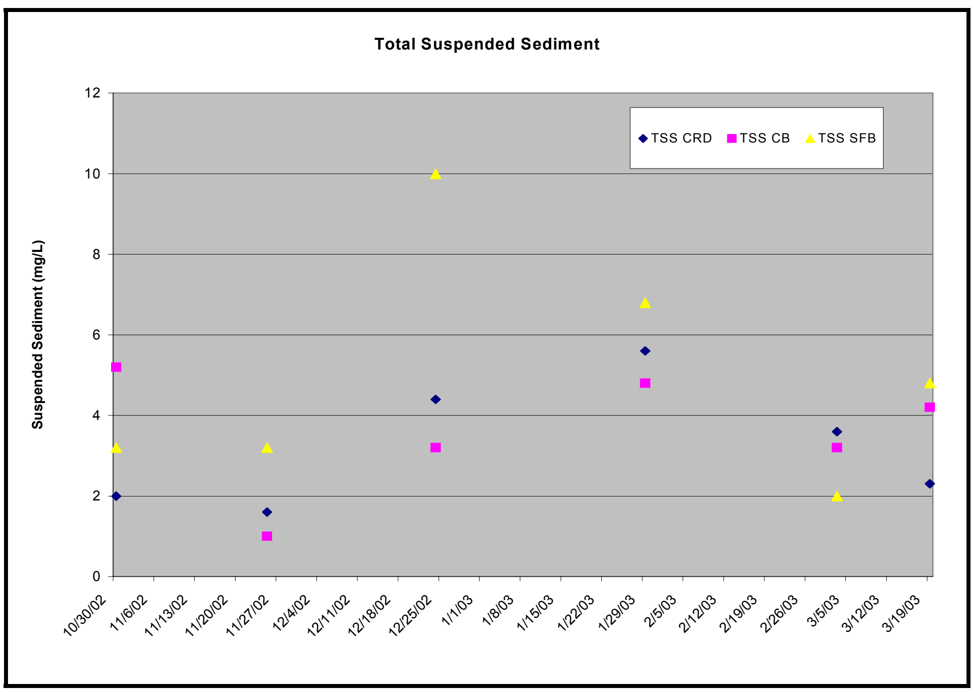

Figure 27. 2003 TSS Concentrations NFPR: Cascade Dam to Smiths Ferry.

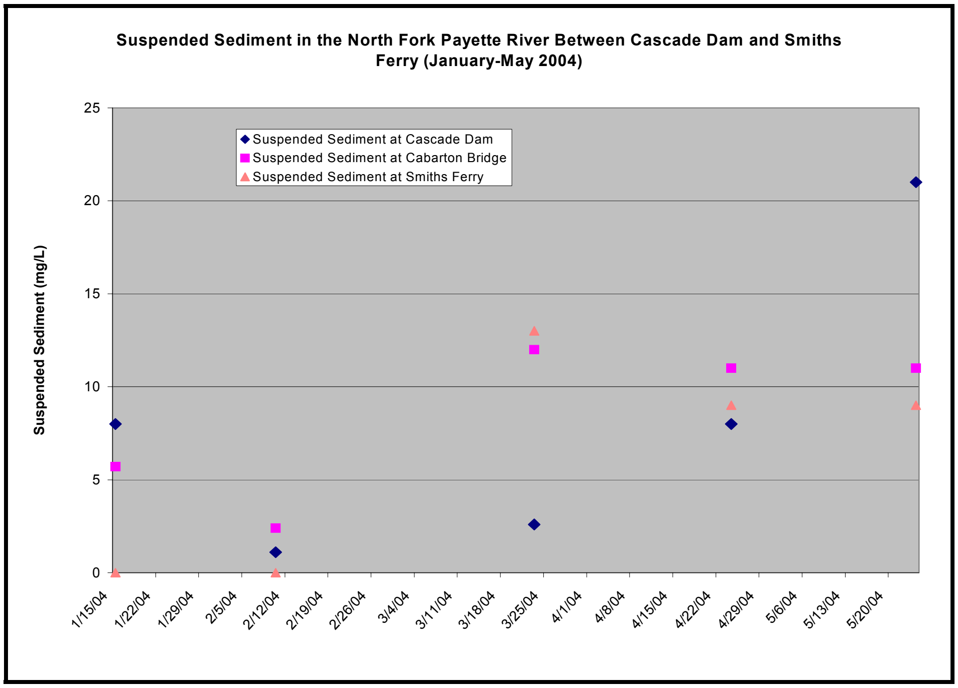

Figure 28. 2004 SSC Concentrations NFPR: Cascade Dam to Smiths Ferry.

However, bedload deposition is likely impairing beneficial uses in the Cabarton reach so a further investigation of sediment sources was undertaken. Suspended sediment sampling was not able to quantify the load of heavier particles, such as sand, that were being delivered into the Clear Creek to Smiths Ferry section.

An aerial photograph analysis of bank stability was done for the banks of the North Fork Payette River from Cascade Dam to Smiths Ferry, because excess bedload was surmised to come from both tributary loading and instream bank erosion from <80% stable streambanks. Streambank erosion was used as a surrogate for bedload sediment.

This analysis showed that the overall average bank stability was 70%, which is below the 80% bank stability target. Thus, excess sediment is being delivered to the river from bank erosion. Bank heights were estimated from the photographs and these values were used to calculate the bank erosion rate.

Temperature

As shown in Figure 29, water exiting Cascade Reservoir is above the state cold water aquatic life temperature criteria in July and early August. The water cools down by the time it reaches Black Canyon Reservoir, primarily due to the cold water influence of the South Fork Payette River. During July and August, the tributaries to the river, with the exception of the South Fork Payette, are generally very small volume streams (<5 cfs) whose input for thermal cooling is negligible (< 5% of total instream flow-calculated over 57 miles of river from Cascade to Horseshoe Bend).

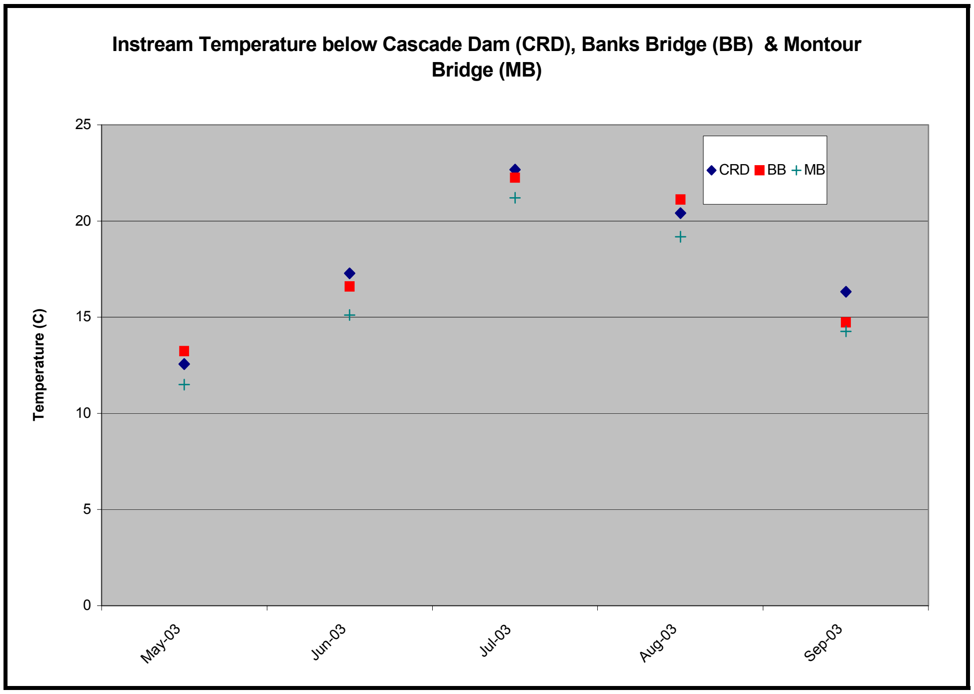

Figure 29. Instantaneous Temperature Measurements: NFPR 2003 (DEQ Data).

The 303 (d) listed stretch of the North Fork Payette River from Clear Creek to Smiths Ferry has historically been managed for timber and, to a lesser extent, for livestock. Several miles of this stretch near the highway are constrained by both the highway on one side and the railroad bed on the other. Both sides have been impacted by the railroad tracks that cross from one side to the other about halfway down the reach. However, as viewed on recent aerial photographs, none of these impacts appear to have affected streamside forest vegetation.

After the North Fork Payette River leaves Cascade Reservoir it weaves its way through an open valley south of the city of Cascade. Clear Creek joins the river near the bottom of the valley (4800 feet) just before the river plunges through a forested canyon known locally as the Cabarton Run. The river runs north to south so the west side of the canyon faces east. The west side is less steep than the west-facing east side. The forest on the west side is more open due to access for forest thinning activities provided by the Cabarton-High Valley Road and because Ponderosa pine is predominant, whereas, the steeper east side tends to have higher density of conifers and slightly more Douglas fir.

Figure 30 shows the difference in instream temperatures between the North Fork Payette River at Cabarton Bridge and at Smiths Ferry. The Smiths Ferry temperatures were warmer until late summer. The cooler Cabarton Bridge temperatures at the end of the summer is likely attributable to the fact that the Cabarton Bridge logger ended up buried in over a foot and half of sand during that time while the Smiths Ferry logger was above the substrate.

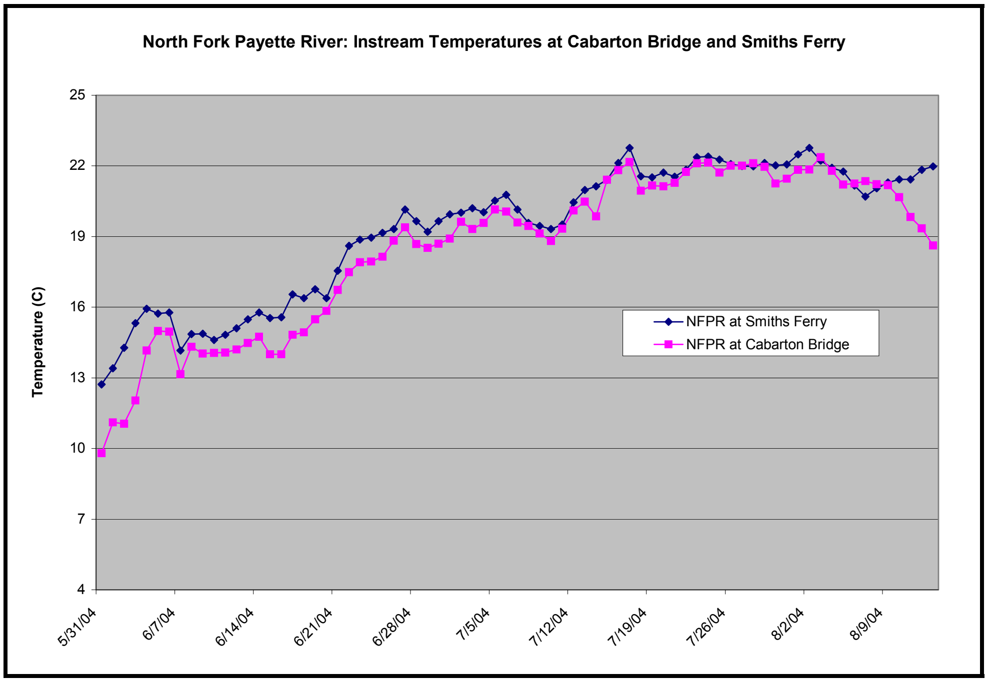

Figure 30. North Fork Payette River Instream Temperatures (DEQ Data).

Since the inflows from tributary streams are negligible in relationship to the volume of water that exits Cascade Dam and the larger tributaries meet the cold water aquatic life standard, DEQ evaluated potential shade to see if temperature were elevated due to anthropogenic effects. Solar pathfinder data and vegetative shading curves were used to evaluate whether increases in temperature in this 10 mile stretch of 303(d) listed river between Cabarton Bridge and Smiths Ferry were greater than those expected if optimal shading conditions existed. Heat inputs from tributaries in this section were estimated to be negligible. Two streams (Fawn and Brush Creek) had temperature logging devices installed during Summer 2004, and both streams met the cold water aquatic life standard indicating that cool water is entering the river.

Shade curves (effective shade and solar radiation versus near stream disturbance zone or stream width) for a Ponderosa pine dominated riparian community and a Douglas fir dominated riparian community were adapted to the North Fork Payette River watershed from the Crooked Creek TMDL (DEQ 2002). Since the riparian communities are a mix of Ponderosa pine and Douglas fir communities, a shade target of 10%, or halfway between the two individual shade curve estimates, was used to represent optimal shading conditions for the river corridor.

In-stream Targets

In the Crooked Creek TMDL (DEQ 2002), a temperature TMDL in the Middle Salmon – Chamberlain Subbasin, shade curves were developed by EPA using computer software developed by the Oregon Department of Environmental Quality. Shade curves (effective shade and solar radiation versus near stream disturbance zone or stream width) were developed for a Ponderosa pine dominated riparian community and a Douglas fir dominated riparian community. This shade curve was adapted to the North Fork Payette River TMDL. The Ponderosa pine community had a weighted average canopy cover of 58%, a weighted average height of 59 feet, and an estimated overhang of 5.9 feet, whereas the Douglas fir community had a weighted average canopy cover and height of 64% and 83 feet, and an estimated overhang of 8.3 feet. Although the curves in that TMDL only extended to a stream width of about 49 feet (15m), extrapolating the curves out to 174 feet (the average width of the NF Payette reach in question, see Table 8) would produce an effective shade of about 20% from the Douglas fir community and close to 0% from the Ponderosa pine community. The Ponderosa pine community on the west bank of the Payette River would produce some shade given the height of those trees, however because of its low density and the width of the river, the resulting shade would be negligible.

Since the forested community on the banks of the North Fork Payette River is a mixture of Ponderosa pine and Douglas fir, shade may be lower than the 20% estimated from shade curves for a Douglas fir community, and yet higher than the negligible amount of shade produced by the Ponderosa pine shade curves. Therefore, for this TMDL a shade target of 10%, or halfway between the two shade curve estimates will be used.

Loading Capacity

Solar Radiation for flat-plate collectors facing south was measured at a National Renewable Energy Lab (NREL) station in Boise, Idaho. Average monthly solar radiation for the six summer months (April through September) as measured by a flat-plate collector with zero tilt ranged from 5.1 kWh/m^2/day in September to 7.6 kWh/m^2/day in July (Table 7). These values correspond to 100% solar input on a flat surface near ground level or 0% shade. Because our shade target is 10% shade, then solar radiation inputs to the river would be 90% of these values or 4.6 kWh/m^2/day in September and 6.8 kWh/m^2/day in July (Table 7).

Table 7. Average Solar Radiation (kWh/m^2/day) for Summer Months at 0% Shade and the 10% Target Shade Levels.

Month	April	May	June	July	August	September	Average
0% Shade	5.3	6.5	7.2	7.6	6.6	5.1	6.4
10% Shade	4.8	5.9	6.5	6.8	5.9	4.6	5.7

Existing Conditions

During the summer of 2004, effective shade was measured using a solar pathfinder at one-mile intervals on the North Fork Payette River from the mouth of the Cabarton canyon (just below Clear Creek) to the meadow opening above Smiths Ferry (Table 8). Additionally, stream widths were measured at every half-mile interval through the same stretch. The average river width was 174 feet and average summer (April – September) shade as measured by the pathfinder varied from 38% to 0%, with the overall average for the reach equaling 13% shade during the six months. Because summer shade is more important from a river temperature standpoint, the average shade during the months of April through September was calculated. Table 8 also presents the average solar radiation to the stream as a result of the shade levels for each month and the summer average.

Table 8. Existing Average Shade, Average Solar Radiation, and River Widths for the NF Payette River Cabarton Reach.

Distance Down stream (miles)	River Width (feet)	April Ave. Shade (%)	May Ave. Shade (%)	June Ave. Shade (%)	July Ave. Shade (%)	Aug. Ave. Shade (%)	Sept. Ave. Shade (%)	Summer (Apr. – Sept.) Ave. Shade (%)
0.0	222	41	33	20	20	35	79	38
0.5	126	-	-	-	-	-	-	-
1.0	234	0	0	0	0	0	0	0
1.5	246	-	-	-	-	-	-	-
2.0	180	25	22	16	22	26	36	24.5
2.5	102	-	-	-	-	-	-	-
3.0	132	27	15	14	15	24	32	18.7
3.5	216	-	-	-	-	-	-	-
4.0	171	0	0	0	0	0	0	0
4.5	255	-	-	-	-	-	-	-
5.0	114	22	22	19	22	28	20	22.2
5.5	114	-	-	-	-	-	-	-
6.0	192	2	2	0	0	3	1	1.3
6.5	129	-	-	-	-	-	-	-
7.0	162	0	0	0	0	0	0	0
Average	174	14.6	11.8	8.6	9.9	14.5	21	13
Solar Radiation (kWh/m^2/day)		4.5	5.7	6.6	6.8	5.6	4.0	5.6

Pathfinder data taken on the North Fork Payette River (Cabarton reach) show that the riparian forest is essentially at its target level. Although the west bank is influenced by the railroad corridor and the logging activities in the forest, it is not likely that any additional shade could be obtained from a Ponderosa pine dominated forest on such a wide river reach.

Conclusions

The reach from Clear Creek to Smiths Ferry does not appear to be impaired by nutrients or suspended sediment and a TMDL is not necessary. Using the Cascade Reservoir nutrient target of 0.1 mg/L for total phosphorus for a river system that discharges into a river, this section will be delisted for nutrients. Similarly, suspended sediment concentrations were far below the suspended sediment targets and suspended sediment will be recommended for delisting from the 303(d) list.

However, there appears to be a large amount of bedload that is being transported downstream into the Cabarton reach (the reach from Clear Creek to Smiths Ferry). Several streams were assessed by the BURP process in the Cabarton reach and all the streams (Fawn Creek, Bogus

Creek, Boulder Creek, Phillips Creek) showed unimpaired beneficial uses and streams in this reach are not suspected to be sediment loaders to the North Fork Payette River. While DEQ was unable to monitor for bedload due to time and sampling constraints, an aerial photograph analysis of bank stability for the North Fork Payette River was completed, showing that bank stability was 70%. This is below the target of 80% stability and a TMDL will be completed for bedload sediment in order to improve sediment conditions downstream. TMDLs recommended for Clear Creek and Round Valley Creek will reduce bedload sediment loading to this section of river.

Instream temperatures are high in the summer months, but these higher temperatures are attributable to warm water released from Cascade Reservoir. While a TMDL might be warranted, it would not be practicable. The water in Cascade Reservoir, the primary source of the heat load, warms up due to the ponding effect of the water body. Since the waters stratify, cooler water is found at lower depth. While a solution to the warmer temperatures might be to release water from the bottom depths, complications would arise from changing the pollution dynamics within the reservoir. Water released from lower depths might be colder but would also likely have lower dissolved oxygen levels and higher nutrient levels due to hypolimnetic conditions near the bottom.

Since temperatures violate the water quality standards, the North Fork Payette River will remain on the 303(d) list for temperature. A determination of natural background temperature needs to be made for Cascade Reservoir, the main instream heat source, to properly evaluate whether the North Fork Payette River system is actually meeting temperature criteria. That evaluation was not within the scope of this TMDL. However, a TMDL is not necessary for the listed reach between Clear Creek and Smiths Ferry because shade targets are met in this reach. In other words, anthropogenic factors in this listed reach are not contributing to higher instream temperatures.

Big Creek

Originating at 6,577 feet near Big Creek summit off of the Warm Lake Highway near Cascade, Big Creek (Figure 32) drains 45,976 acres before entering the North Fork Payette River below Cascade Dam at 4,723 feet. Land uses include timber harvest and pasture as shown in Figure 34. Forestry is currently practiced on 17,442 acres of the Big Creek watershed (Figure 31). The area of canopy removed through timber harvest and road construction is estimated to be 1,511 acres (IDL 2002). The watershed is primarily public land managed by the USFS with about 20% private landholdings in the middle and lower portions of the watershed.

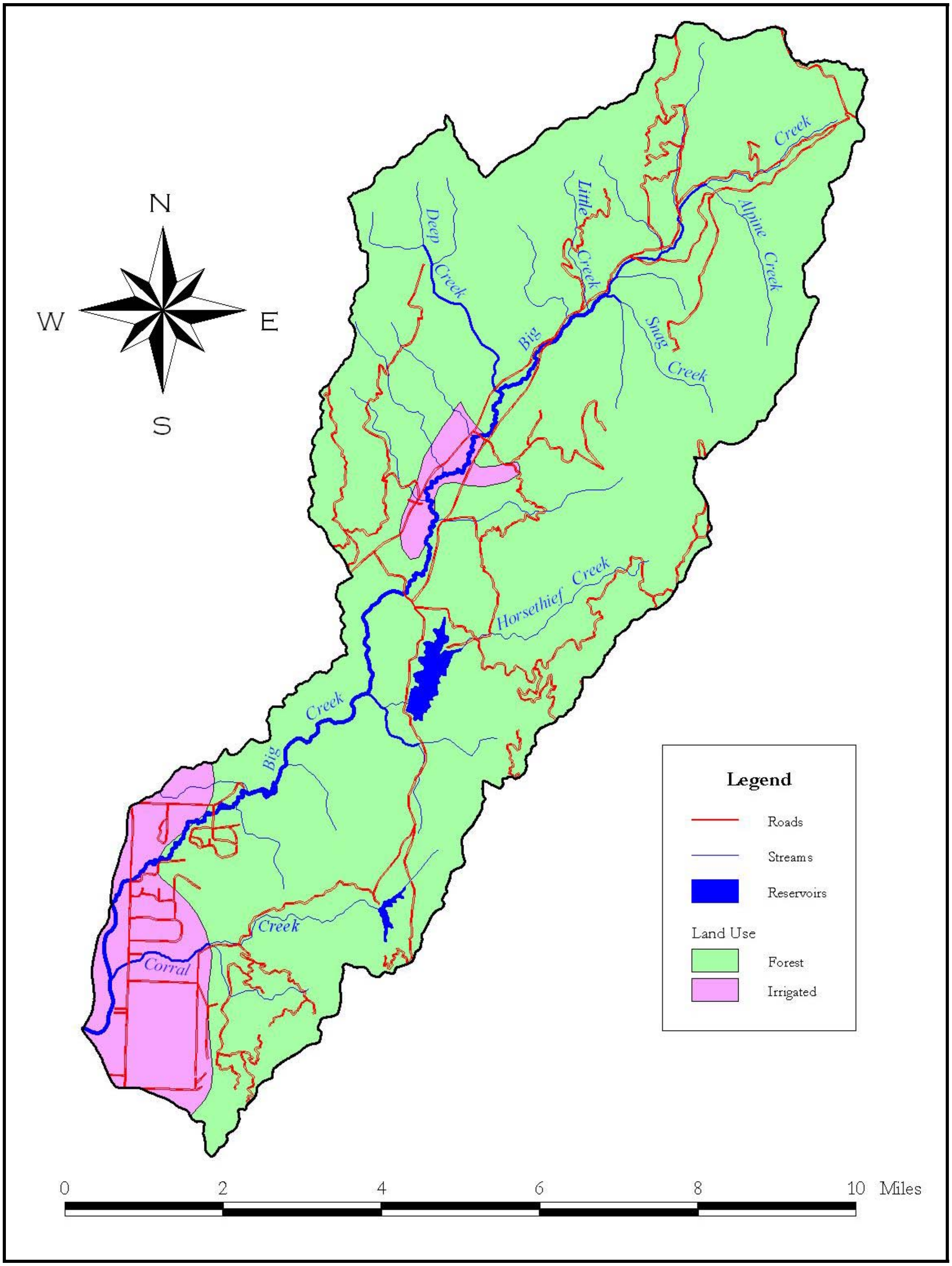

Figure 31. Big Creek Hydrology and Land Use.

Figure 32. Big Creek-Upper Reach.

Horsethief Reservoir, fed by Horsethief Creek, is located in this watershed and is a popular fishery for recreationists. Idaho Fish and Game owns and operates this reservoir, managing it primarily as a trout fishery. Constructed in 1963, the reservoir stores 4900 acre-feet at full pool, which Idaho Fish and Game tries to maintain year round. In 1994 an estimated 30,000 angler hours occurred on the reservoir from May 1 to July 30 and in the same period 7,400 tents/campers were counted (IDWR 1999). The 275-acre reservoir is maintained by the Idaho Department of Fish and Game (IDFG) as a hatchery supported fishery due to high angler use. Species found in the coldwater reservoir include rainbow trout, trout hybrids, brook trout, brown trout, yellow perch and splake.

Big Creek is a third order stream with a dendritic pattern. A Rosgen type A stream in the headwaters, Big Creek shows mainly Rosgen B and C characteristics in the lower gradient reaches. Floodplain widths vary from six to fifty feet in the Rosgen B and C channel areas. The stream channels are slightly entrenched.

Vegetation in this subwatershed varies with elevation and aspect. On north slopes and with increasing elevation, forest stands become denser with a larger number of coniferous species. At lower elevations and on southeast to northwest facing slopes, ponderosa pines, forbs and grasses are prevalent (IDL 2002).

The geology in the area predominantly consists of highly and weakly weathered granitics. Highly weathered material is found mainly in the mainstem and lower tributary floodplains (IDL 2002).

In response to the threat of the Cold War in the early 1950s, the lower portion of Big Creek was dredged for monazite which is a radioactive phosphate. While this dredging operation only occurred for a few years, 7,085 short tons were removed and the tailing piles are still present. This legacy activity has influenced the morphology of the lowermost reaches near the mouth of Big Creek.

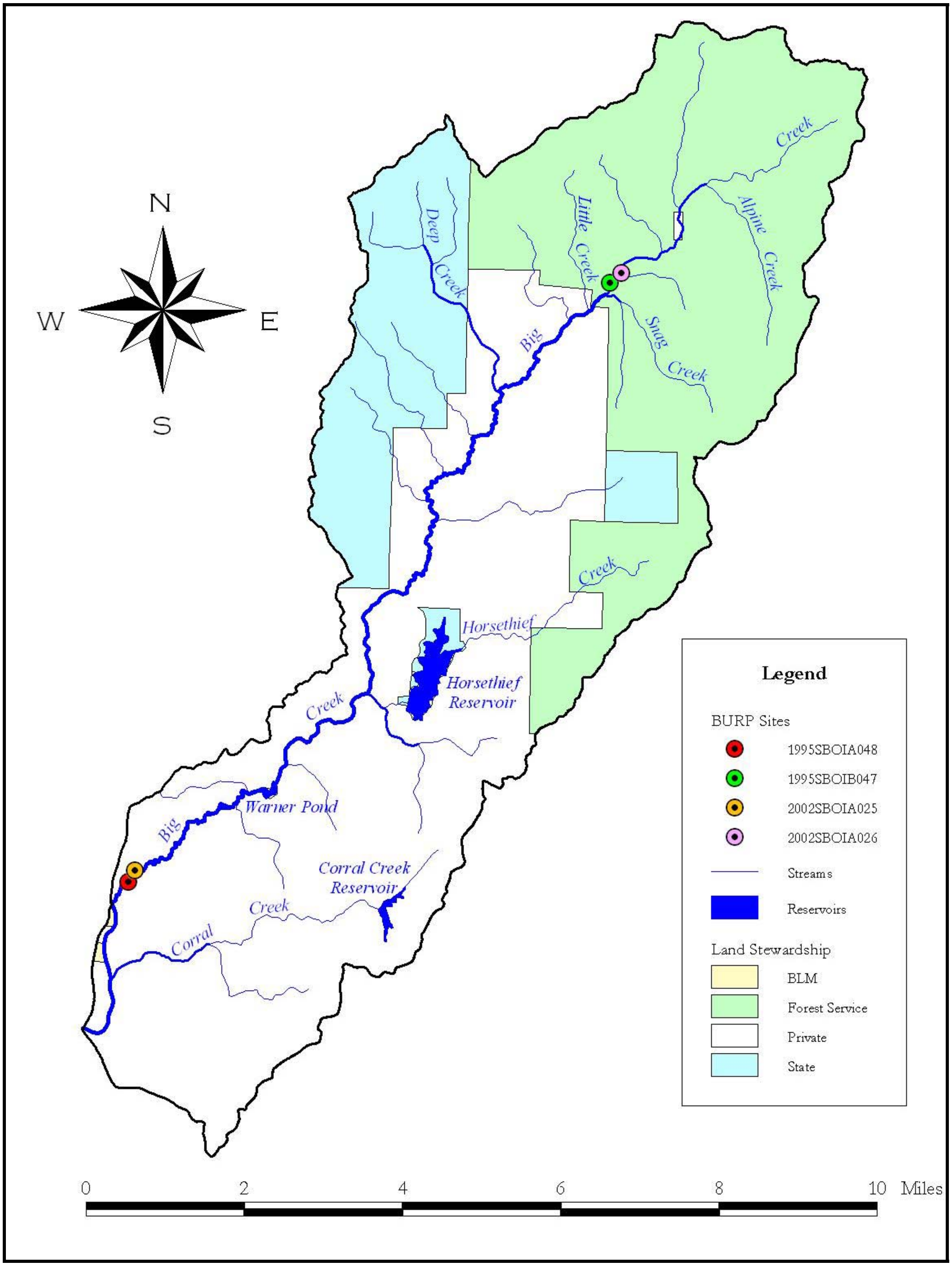

Figure 33. Big Creek Monitoring Locations.

Flow Characteristics

Very little hydrology information is available for Big Creek. However, Big Creek typically peaks in May as a result of snowmelt. High flows near the mouth of Big Creek typically go over the banks in above average water years. Base flows are less than 5 cfs near the mouth and generally occur in late summer and fall.

Biological/Habitat Data

DEQ stream inventory results showed that beneficial uses were supported in the upper reaches but not in the lower reaches (Table 9). Monitoring locations are shown in Figure 33. DEQ found high percent fines in the lower reaches of Big Creek (Table 10). The Idaho Department of Lands evaluated 38.7 miles of forest roads in the watershed, which was more than a third of all forest roads. The road inventory and mass failure inventory of the Big Creek watershed showed a low sediment delivery rating. However, sediment delivery from skid trails showed a high potential. There are no actively used or new skid trails in the stream protection zone. However, historically, skid trails were located in the stream protection zone. The mass failure hazard rating was moderate (IDL 2002). The lack of roads adjacent to the stream and upstream sources of sediment (i.e. timber harvest and associated road building), led DEQ to investigate instream channel erosion as the primary source of excess sediment. The other source of sediment may be historic sediment delivery from the dredging operations.

Table 9. Big Creek: DEQ Water Body Assessment Scores.

Stream ID	Stream Name (reach)	SHI	SMI	SFI	Water Body Assessment Score	Beneficial Use Support Status
2002SBOIA025	BIG CREEK (LOWER)	0	1	No data	<1	Not Full Support
2002SBOIA026	BIG CREEK (UPPER)	3	3	No data	3	Full Support
1995SBOIA048	BIG CREEK (LOWER)	1	<Min	No data	<1	Not Full Support
1995SBOIB047	BIG CREEK (UPPER)	2	3	No data	2.5	Full Support

Table 10. Percent Surface Fines in Lower Reaches of Big Creek.

Stream ID	Stream	Percent Fines
2002SBOIA025	Big Creek	49
1995SBOIA048	Big Creek-Lower Reach	78

DEQ attempted to do channel erosion inventories in the section of Big Creek below Horsethief Creek during Summer 2004. Unfortunately, DEQ was unable to gain access to a *representative sample* of the section of river at and above the tailings piles. The middle reaches of Big Creek (upstream of Highway 55 but below Warner Pond) appeared to have stable banks in some sections and excessive erosion in others. 2002 DEQ stream inventory bank stability scores for Big Creek in the lower reach showed banks that were 90% stable. DEQ was able to characterize the lower portion of Big Creek below Highway 55 and determine that bank erosion was not a significant source of sediment to the stream. Banks were greater than 85% stable throughout the reach, and, in many portions of the lower section, the stream dissipates energy by overflowing its banks. DEQ extrapolated the data acquired in a stretch of the creek between Highway 55 and Warner Pond to areas in the reach that appeared <80% stable in aerial photos. Aerial photos were also used to determine areas that were >80% stable. If additional information becomes available, the erosion inventory will be refined, which would be reflected in the TMDL allocation.

Conclusions

Big Creek is listed on the 1998 303(d) list for sediment from Horsethief Creek to the Mouth. The watershed above Horsethief Creek does not show impairment of beneficial uses nor does it appear to be a source of excess sediment to downstream waters. The beneficial uses in the lower reaches of Big Creek are impaired, and a TMDL is necessary to restore these beneficial uses.

Part of the sediment delivery is attributable to changes in morphology resulting from historic dredging and the discharge of tons of fine material to the stream which resulted in over widening of the stream channel. DEQ will also take a closer look at land use practices within the watershed to rule out other sources of sediment. A TMDL will be developed for sediment that takes into account the unique morphological characteristics of Big Creek.

Black Canyon Reservoir

Black Canyon Reservoir is a run-of-the-river reservoir that impounds up to 29,300 acre-feet of water and is six miles long (Figures 34 and 35). In general, the reservoir is managed so that reservoir levels remain fairly static. Located at an elevation of about 2,900 feet in Gem County, the reservoir is surrounded by an arid, butte-studded landscape. The upper end of the reservoir is very shallow due to sedimentation.

Currently, sediment fills approximately 35% of the reservoir, reducing the total active storage capacity from approximately 44,800 acre-feet originally to 29,300 acre-feet (BOR 2004). Since water slows in velocity as it enters the reservoir, the bulk of the deposition occurs at the upper end of the reservoir. This action effectively filled the original channel and impedes the normal flow of water into the reservoir, resulting in a significant extension of the 100-year floodplain at the confluence of the Payette River and Black Canyon Reservoir.

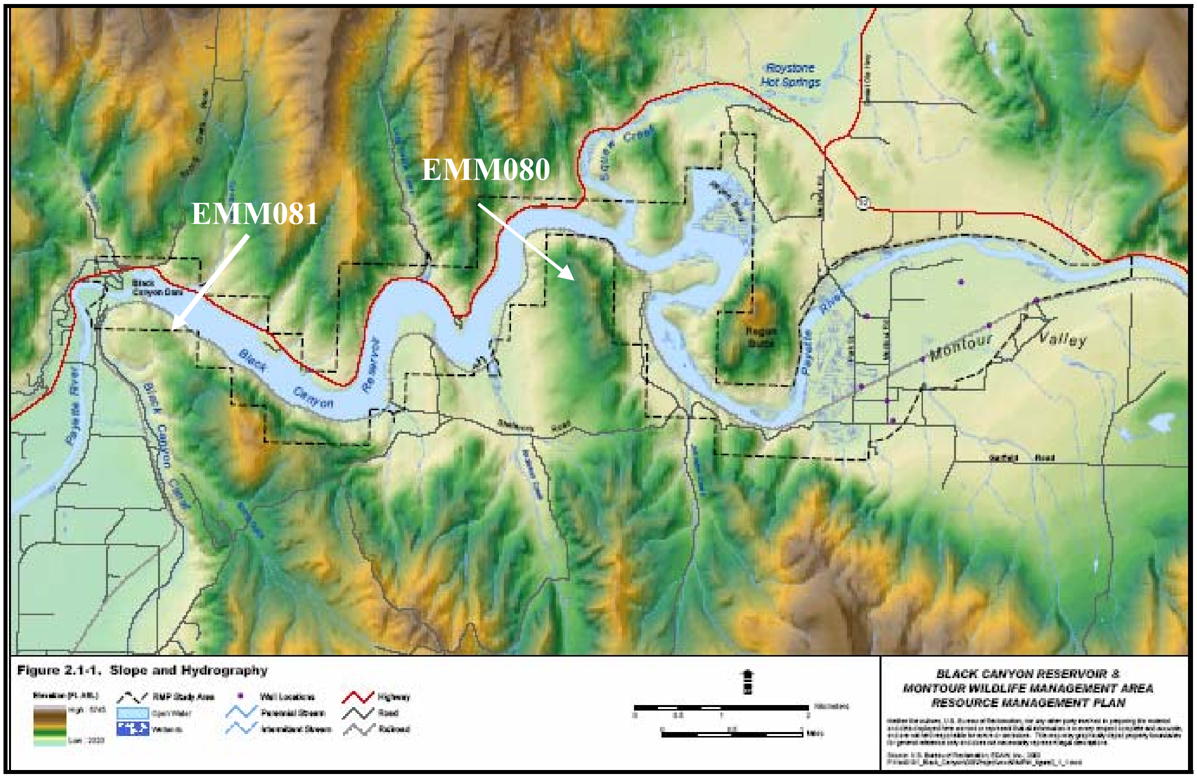

Figure 34. Slope, Hydrography and Approximate Location of Monitoring Sites in Black Canyon Reservoir Area (Figure appears courtesy of BOR)

Figure 35. Black Canyon Reservoir.

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The water level of Black Canyon Reservoir is typically maintained within 0.1 feet of full pool (2,497.5 feet) during the irrigation season to ensure full diversion capability. The